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BIOLOGY AND CHRISTIAN BELIEF

BY

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WITH A FOREWORD BY
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FOREWORD

In 1691 John Ray wrote a book called *The Wisdom of God Manifested in the Works of the Creation,* in which he pointed out that everything in the universe, from the fixed stars to the chameleon's tongue, was " argumentative of Providence and Design " and that their existence was evidence of the " Direction of a Superior Cause ".

The naïveté of this simple view was not allowed to go unchallenged, and the discoveries of the nineteenth century provided a body of facts which the materially-minded were not slow to grasp. For at the beginning of that century John Dalton enunciated his Atomic Theory as a quantitative restatement of the atomistic notions of Lucretius, while in 1859 Charles Darwin published his theory of the *Origin of Species by Natural Selection,* which, in somewhat the same way, first made men believe in the reality of Evolution.

The striking success of these scientific hypotheses gave such apparent support to the forces of Materialism that by the year 1900 it might have been said, in triumph or regret, that God as a personal Creator was being driven out of His universe. It looked as though we of the twentieth century must be prepared for anything.

In the event, the actual consequences have been surprising. The pendulum has swung back from the extreme materialism of earlier days, and one of the most conspicuous features of the deservedly popular works of Sir James Jeans and Sir Arthur Eddington has been their detection in the universe as a whole of evidence of a design and a purpose. This reappearance of Indeterminism in modern science is Dr. Greenwood's chief theme.

Dr. Greenwood is to be trusted as a biologist, and, indeed, as a scientist generally, if by that much-abused word we mean one who makes dispassionate and logical deductions from established facts. He has given an admirably lucid review of the fundamentals of some of the modern concepts of Physics and Biology, and his book is to be unhesitatingly commended to all who, more than a little bewildered by the rapid advance of learning, wish to be assured that the bases of the Christian Faith remain unshaken.

It is a mistake to condemn all who call themselves mechanists. The neo-mechanist of to-day freely admits that the physics and chemistry of biological events are only an abstraction, representing a single point of view. He finds himself compelled to work *as if* the mechanistic theories were an expression of truth, but he is not compelled to accept them as ontological statements of fact. Moreover, Professor Stebbing has recently developed the thesis that the views of Jeans and Eddington are the product of an anthropomorphism which leaves the philosophical issues untouched by scientific discovery.

And so differences of opinion persist and arguments proceed. It is not claimed that Dr. Greenwood has spoken the last word, but it is well to be assured that his deductions from fact are always entirely legitimate.

THEODORE H. SAVORY.

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PREFACE

THERE can be little doubt that Christianity is passing through a very momentous crisis. The bare statement needs little or no comment: the urgency, from the most responsible heads, embodied in such appeals as *The Way of Renewal, The Recall to Religion* are evidences enough of the concern of those who are in a position to know. The Churches are plainly hemmed about by bitterly antagonistic elements. Whole nations have been compelled to renounce everything religious and the attack has openly been concentrated upon Christianity in particular. The State has become a god; it has become a vast machine; patriotism has been killed, because patriotism connotes freedom of choice (since a person may be unpatriotic if a choice is open). Mechanism has become the dominating feature over populations numbered in hundreds of millions.

Now the causes of the change in outlook are unquestionably many and complex, but one of the deepest of them takes its origin in the supposed verdict of science. It is contended by many that the mechanistic conceptions in science have abolished all need for God. He is no longer even a useful *hypothesis*. Such a contention is indeed unqualified dogmatism, which is condemned heartily by Sullivan and Sir Arthur Eddington alike, to say nothing of Professor Whitehead. It is exactly at this point where the Christian crosses swords with the mechanistic biologist. There is not, and indeed cannot be, any quarrel with the pursuit of mechanistic application as far as it may legitimately be carried. The method of interpretation will probably be used and pushed much farther than at present. Within its own sphere it is a fruitful method, yet that is not to say it is the final explanation and the Christian is not alone in maintaining this, for many of the most eminent biologists (freely quoted in the following pages) are quite agreed that mechanistic explanations are *not* final ones—they go farther and say they can see no prospect of such explanations ever being final.

Because of this sharp division of opinion an attempt has been made in the present book to point out the *ultimate* insufficiency of this belief of many biologists. It would be a mistake to suppose that all biologists are anti-Christian—they are not by any means, but it so happens that the others rarely put their views before the public, and the materialistic propagandist thus appears to hold the field. No wonder if thoughtful Christians are sometimes disturbed by a formidable array of biological opinion, to which there *appears* to be no reply and from which there seems to be small chance of escape.

The object of this work, therefore, is to give to educated people who have had no opportunity of studying biology at first hand, the alternative view that, however completely the biologist carries out his investigations on the assumption that organisms are mechanisms (as they are), it does not follow that all Christian teaching and belief are hopelessly shattered. Further, an attempt is made to show that even science is one of God's methods of revelation of Himself. The great majority of scientists frankly acknowledge some form of theism; many are emphatic in this belief, as will be seen from the numerous references to their works.

The book is admittedly popular in its form, but it is hoped that accuracy has not been sacrificed. Deductions and conclusions may very well prove not to be final but it is felt they are steps in the right direction and as such may lead to further and more complete interpretations. It will be noticed that no appeal is made to a vitalistic principle such as Driesch's " entelechy " or Moore's " biotic energy "—perhaps science in the near future will give us a more definite lead in these directions. Newtonian mechanics held the field and proved to be accurate enough until Planck's quantum and Einstein's relativity demanded a revision of concept. The need for restatement now does not detract from the genius of Newton nor render his mechanics obsolete. So, too, the time may be close at hand when *all* biologists may be compelled to recognize that something beyond " mechanism " is necessary to provide the ultimate correlation and explanation that many even now consider to be needed. The penetrating intellect of a biological Einstein will then weld Darwin's and that of his followers into one harmonious whole. The seeds may well be already lying in some such philosophical integration as General Smuts' *Holism*.

The limitations imposed on the scope of this volume will be obvious to those who possess even a fair biological knowledge. Important topics such as Anthropology and Miracles (viewed from the biological standpoint) have had to be omitted.

It remains to thank Mr. Humphrey Toulmin and the Cayme Press Limited for their generous permission to quote so freely from the collected poems of the doctor, scientist and poet, the late Ronald Campbell Macfie.

W. OSBORNE GREENWOOD.

HARROGATE.

CHAPTER I

INTRODUCTION

WHEN the subject of Religion, in any general conversation, is mentioned in association with Science, it seems almost inevitable that some sort of conflict is implied. The two words appear instinctively to call up a picture of two armies, ranged in battle array, which armies are traditionally assumed to be compelled to fight to the death. If this were true it would mean the extinction of one of them. Yet after hundreds of years of "war to the knife" this is precisely what has not happened. How far we may entertain the notion that each has some phœnix-like capacity, by which the fierce flames of destruction generate anew the dying remains, we will not stay to inquire. Such a fanciful quest would not greatly help towards the solution we seek.

It is true there are still fanatics on each "side" of this supposed "conflict," who would continually stir the flame of a distrust that, to the saner among the populace, is fast disappearing. Our object, therefore, is to attempt a calm and dispassionate review of the present-day position. There will be occasion for plain speaking, for we must face the facts as they bear upon our inquiry, but bitterness and spleen will be left to those who delight to tinge all discussion with qualities that cannot be admired.

For the purposes of this investigation and restatement, we may broadly divide the sciences into physical and biological. Not that we can take every separate science and cut it off sharply from every other department of knowledge. Each one impinges upon and ramifies widely into the others. We shall meet with many such instances of interpenetration in the course of our inquiry, but in a broad sense this division is found to be advantageous. We speak, then, of the physical sciences—those such as physics, chemistry, mathematics, astronomy, astrophysics and so on; while the biological ones include zoology, botany, anthropology, physiology and those related to these. Thus medicine studies abnormal aspects and manifestations of life with the intent to influence these states for the better. Bacteriology deals with the microscopic forms of life which interfere with the health of human beings, animals and even plants. The biological sciences thus deal, directly or indirectly, with all life processes. Until recently these two broad avenues of knowledge were regarded as distinct, but for some time now serious attempts have been and are being made to bridge the gaps which appeared to exist. As examples, we need only mention the newer sciences of bio-chemistry and biophysics where attempts are made to penetrate the actual chemical and physical processes which occur in the living organisms or even in tissues removed from the animals in question. By using suitable methods it is now possible to keep alive, even for years, such highly developed and complex tissues as pieces of separated muscle, even heart muscle and the whole heart. The constituent cells grow and multiply under the artificial modes of living imposed upon them.

As the biological problems will form the main themes of this book we shall necessarily have to return to them and review them in much greater detail. The above preliminary sketch has been given, however, with a specific object, for many of the investigations belonging to these subjects involve intense specialization and concentration upon the methods suitable to the particular research that is being undertaken. The extreme delicacy of the appropriate experiments demand this whole-hearted specialization and concentration. Now while such knowledge as this is much to be desired there is only too often an inevitable penalty associated with its prosecution. It is that these students lose much of the true view of other matters; they become, as it were, myopic to all but their own immediate interests; they are isolated peaks, majestic no doubt, but the very isolation has robbed them of the stabilizing sense of perspective. This, coupled with the fact that the biologist devotes his energies to watching, as far as he may, the chemical and physical processes of life, has probably led him to assume that here, in these processes themselves, he is in the presence of life itself. By elucidating the physical and chemical changes which necessarily accompany life, it seems to him a tempting assumption that he is stripping away curtain after curtain, until very soon, if not already, he has laid bare the mystery of life's real essence. It would be a mistake if the impression were conveyed that all biologists hold these views—far from it, as will presently be shown, but it so happens that those who do hold them are particularly active in spreading their opinions by means of writings, lectures and other opportunities, that by comparison there is a relative dearth of definite propaganda from those who have come to very different conclusions.

Far removed from this verdict of the biologists is that pronounced by exponents of the physical sciences. They are just as earnest as the others in their quest of an explanation of man's physical environment. During the last forty years discovery after discovery has streamed forth from their work until the physical scientific world stands almost breathless in expectancy of what may next emerge. So revolutionary and in a sense contradictory are the findings that physical scientists for the most part are compelled to postulate a Master Mind in order to invest the physical cosmos with even the semblance of rationality. In the history of Science the situation thus revealed must be to a large extent unique—the biologist, emphatic in his contention of determinism, utter materialism (so-called dialectical, if you like), mechanism pure and simple: the physical scientist just as emphatic in his contention of in-determinism, complete immaterialism and the total failure of mechanistic interpretation as offering so much as an approach to any explanation of the cosmos. We are to examine the claims of these two opposing factions and attempt to come to some sort of decision. For this purpose (although our concern will very largely be with biology) we must first set out a brief statement of the conclusions of the physical scientists and proceed to build up our biological conceptions upon an equally rational basis.

CHAPTER II

WHAT THE PHYSICAL WORLD IS LIKE

In the preceding chapter we have seen what a remarkable cleavage exists in the interpretation of nature between the physical scientists and those concerned with the problems of life, the biologists. Perhaps it ought to be stressed that it is in the interpretation that the cleavage occurs. It is not among the facts belonging to the several sciences that contradictions occur, for after all knowledge is divided quite arbitrarily into these sciences solely for the purpose of more conveniently handling the mass of knowledge that is now accumulating. Whatever else may be true or false we are bound to recognize that nature is, and must be, a unity; there is a wholeness here from which we cannot escape. The various scientists have their own ways of seeking a solution which will confer an essential and enduring unity on our knowledge and it is just as legitimate for the Christian to insist that he also has something to say about the problem.

At the outset of any inquiry we are faced with three primaries—Matter, Life and Mind. These, says General Smuts, are utterly unlike each other and their differences appear to be ultimate (*Holism and Evolution,* p. 2). The problem of synthesizing and unifying them was supposed to be virtually solved towards the end of last century, but the mechanistic solution then offered has proved to be unsatisfactory when pursued to its limits. During the last eighty years or so three upheavals have shaken the scientific world—the publication of Darwin's theory of Natural Selection, in 1859; the discovery by Becquerel of radio-activity in 1896; the enunciation by Einstein of the general theory of Relativity in 1915. These have had the profoundest influence on scientific thought and attitude.

Before approaching biological considerations, involving some discussion on the nature and characteristics of living material, we must inquire what the physicists and the astronomers have to say about the nature and structure of matter, since life, and hence also mind, manifest themselves on this earth through the medium of matter.

The second of the above revolutionary discoveries, viz. radio-activity, may well be taken as an introduction to a brief review of the nature of the physical universe. Up to this time it was supposed that our knowledge about the atom was virtually complete and final; small gaps there were, but the essential facts were regarded as known. Everything about us was said to be very solid, material. Even the gases and liquids are in reality these solids very much thinned out. The substances which go to build up our world and even our bodies are thousands in number but almost all of them are compound bodies, not simple ones. They can be broken up into very much simpler substances. Thus table salt is made up of two, prussic acid of three, sodium bicarbonate of four of these simple bodies, and so on. When we break up table salt we are left with two substances which by ordinary methods cannot be further resolved into anything simpler: so also in the case of prussic acid we are left with three. These simplest bodies are called elements and there are 92 of them known to us. There may be more somewhere out in space, but if so we have no knowledge of them. Hydrogen is the simplest and lightest of them, and on arranging the elements in order we have a complete series from 1 to 92. The last is the most complex and the heaviest—it is called Uranium. Between Hydrogen and Uranium all other elements come in their order: thus Helium is 2, Carbon is 6, Oxygen is 8, Sulphur 16, Silver 47, Gold 79, Lead 82. If we take a very tiny bit of any one of these, theoretically we divide and divide it smaller and smaller until we come to a point where any further subdivision by ordinary means is impossible. In the case of gold, say, we have come to the smallest particle *which can exist as gold.* By special methods a few of the elements *can* be subdivided still further, but, if it were iron or silver, it would cease to be iron or silver. The particle beyond which we cannot ordinarily go is called the Atom. Thus every element has its own type of built-up atom, which differs from the atom of every other element. It is the structure of the atom that concerns us.

Suppose we begin with the hydrogen atom. Until radio-activity was discovered the atom was regarded as a solid bit of material, something like a marble. The more complicated ones, such as iron, lead, etc., are naturally heavier, although their sizes do not vary as much as might be thought. A fair average size of an atom is about $\frac{1}{150000000}$ of an inch in diameter, which means that it would need some 150,000,000 placed side by side to cover a line an inch long. Roughly speaking, if we put atoms into a tiny box $\frac{1}{16}$ of an inch long and broad and high there would be no less than 1,000,000,000,000,000,000,000 atoms scurrying about inside if they were liquid or gaseous.

We know to-day, however, that the atom has a very different structure from that presumed some forty years ago. We picture it as almost infinitely more complicated than a cherry-stone or a marble, for each one consists of a core or kernel, round which from 1 to 92 bodies are madly revolving, according to the complexity of the element. Thus hydrogen has one core (called a nucleus) and round this there revolves a body with a speed approaching that of light. Sometimes it revolves nearer to the centre, sometimes farther away. But the distance of the orbit of revolution is not just anywhere and arbitrary. There are definite orbits, and the circulating body, if it moves inwards or outwards, must jump to another orbit—never between. The central body is named a proton and has always an exact quantity of positive electricity. The circulating body, named an electron, has an exactly equal quantity of negative electricity; so that, could the two merge into one, the one electrical quantity would perfectly neutralize the other. Under certain conditions this happens, but the nothingness is transformed into radiations—the energy each one possessed is not destroyed, it is changed. We are familiar with some of these changes in everyday life, such as when we " switch on " electricity in our homes, part of the current may become light, part of it heat, part of it may be made to do work, as when it operates a fan or sets machinery in motion.

We must return to the proton and electron. It may be remarked that recently there has been a further resolution into positron, neutron; heavy hydrogen has been discovered and heavy water too—a water that is 11% heavier than ordinary water. These refinements, however, have no bearing on the argument I am about to pursue and can be neglected. The proton, then, is not merely a + charge of electricity; one of its properties is remarkable, for its weight is about 1,840 times that of an electron. Thus we may say, for all intents and purposes, that the weight of a hydrogen atom resides in the proton alone. That is a remarkable and unexpected fact.

Now look at the helium atom. Its weight is four times that of hydrogen, and in view of what has just been said we might expect its nucleus to consist of four protons, and this is indeed the fact. But instead of having four electrons circulating in their different orbits to neutralize the charge of the protons, two of them are locked up in the nucleus and neutralize two protons, the remaining two revolve round the now compound nucleus. Exactly the same obtains as we climb the series of elements. Lithium, the third one, is six times the weight of hydrogen and therefore has six protons: three electrons are locked up with the protons, while three revolve. Similarly carbon is twelve times the weight of hydrogen; six combined electrons and six circulating complete the atom; and carbon is the sixth element in the series. Higher in the series the electrons are not equally divided between the nucleus and the orbits. Thus the last one, uranium, has weight 238, while 92 electrons revolve. A significant fact, however, emerges—the weight depends upon the number of protons in the nucleus, while the number of circulating electrons gives us the atomic number; in other words, gives us the position of that atom in the series. If we ask, how many electrons are " combined " in the nucleus, the reply is the difference between the weight of the atom and its atomic number. For uranium, 238 minus 92 gives 146; i.e. the 146 represents the number of electrons fixed in the nucleus by the 238 protons. Put in another way, we see the uranium nucleus is only partially satisfied, but that this satisfaction is completed by the revolving 92 electrons.

We now come to the facts which will make up the last link in the chain of the argument I am pursuing. It has been said earlier that last century's scientists conceived atoms as being somewhat like cherry-stones or marbles—hard, rounded, solid. It is well known now, of course, that such a picture is entirely wrong. When, however, we have resolved an atom into its protons and electrons, are these the solid material bodies pictured by the last century physicists? Not at all, for there is nothing whatever in an atom which corresponds with what, in ordinary commonsense language, is called material or solid. Suppose we confine our attention to electrons, the bodies which whirl round protons in mad career. An electron is now known to be simply a disturbance of space; we can call space ether if we like, although mathematicians tell us we need not postulate anything except merely space. Perhaps it will help most people's understanding if we speak of ether, although we have not any means of *picturing* in our minds what ether may be like. Well, electrons are disturbances in the nature of waves in the ether, which, as far as trying to imagine what they are like is concerned, is equivalent to saying—disturbances of nothing in nothingness, as Poincaré, the French mathematician, paradoxically puts it! These waves are called group waves. We get a very rough notion regarding group waves by an analogy. If we throw stones into a pond, each one sends out a series of circular waves, the smaller becoming larger and following the larger in ever-widening paths. Where the waves from one stone meet those from another stone the wave becomes more complicated. Here two crests will coincide, and, added together, will produce a crest the height of the two together: there two troughs will meet and produce a deeper trough. This is a very crude and coarse way of trying to picture group waves—the true ones are infinitely more complicated and would baffle our understanding, but it is useful to have some sort of a peg on which we may hang our ideas. An amazing fact is that these points of group waves may move with a speed approaching that of light (which travels at 186,000 miles per second). One more fact. The points of group waves (shall we call them particles?) do not move in any haphazard fashion, they are actually guided and directed by what are called constituent waves. When the group waves move more slowly the constituent ones move more quickly, and what is stranger still, the guiding waves *do not use or show any trace of energy.*[1] The significance of this will be dwelt upon later. Meantime, the point of overwhelming importance for us to grasp is, that in our examination of the structure of the unit itself, from which all so-called matter is built, there is nothing in the least corresponding with our ordinary notions of "matter." Waves and disturbances are all we find, and if there is nothing in this world that can be regarded as material, then there cannot, *ipso facto*, be any foundation for a philosophy of materialism. Instead, we are led, step by step, to see ordinary substantiality literally melting away before the eye of reason, destroying the things which seem most real of all to our senses. In its place we are introduced to an immaterial basis and foundation which physicists, whose business it is to investigate these things, assure us that no logic can confute. Thus they and the astrophysicists would almost seem to have conspired and revolted against all materialism and put the very words into the mouth of the late Viscount Haldane, "The more things are interpreted as spiritual, the more they are found to be real."[1] Here, then, on the very threshold of our inquiry, while we attempt to extract some meaning from the very elementals, we are met with the arresting suggestion that, lying at the heart of the apparently material, is the presence of what we must call spiritual.

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[1] See Sir Oliver Lodge's book *Beyond Physics*, pp. 141 to 148.

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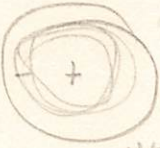
[1] *Mind and Reality*, p. 31, by Viscount Haldane.

molecule - matter
atoms
Protons & Electrons - equal in
+ − quantity + & −



disturbance in
space (ether) in
nature of waves
group waves
guided + directed

Under certain con-
ditions these merge
+ perfectly neutralize each
other - transformed into
radiations - energy not
destroyed but changed.

not substance so much
as spirit
Revolt against
materialism.
Haldane

Snap switch - light
heat
work - setting
machinery to work

Class:
Paper: astro-Physics-Theology
-Short-

god -

CHAPTER III

THE UNIVERSE

In our first contact with this study we have been trying to envisage what may legitimately be called the infinitely small, for although we have accustomed ourselves to speaking glibly about millions of millions, and even accurately calculating sizes and distances of these orders, it is quite certain that no mind can have an adequate conception of what they mean. Keeping this reservation before us, we are going now to the opposite extreme to look upon the infinitely large. My thesis is that we shall here come upon the same kind of arresting knowledge, knowledge which will compel us to a like conclusion.

Our universe (for it is but one of many) is composed of vast numbers of stars, all of which are similar to our own sun, which is a very moderate type, neither very old nor very young, of a medium size as suns go, neither as fiercely hot as some, nor yet as cold. It has reached staid middle life. It is one of some 30,000,000,000—a large family even for a universe. As we all know, it is physically responsible for all the life on this earth. In the process of supporting life the sun must give off energy in the shape of light, heat, etc. The energy so given off is being radiated into space in every direction and of it the earth can only take an almost infinitely tiny fraction. The energy radiated from the sun (or any star) used to be considered a result of some form of combustion, just as though so much coal were being consumed on every square yard of its surface. It is now known to be due to the destruction of matter which thus changes into energy. In fact energy and matter are interchangeable and when we speak of such destruction of matter we mean it has only been transformed and has not been literally destroyed. Now the sun is giving off its energy so prodigally that it is losing weight at the rate of 360,000,000,000 tons a day, yet so vast is it (capable of holding a million worlds like ours) that there will be little difference in its size and activity a million years from now. There are stars which are as much larger than our sun as the sun is larger than the world, while on the other hand many are smaller. The largest ones we know are probably at about the extreme limit of size possible, even for a sun. All grades of activity are to be found, from the most intense even down to death, by which is meant that the star pursues its way, inert and dead, i.e. it has ceased to give off any radiations and of course emits no light. From birth to adult life, through middle age to senility and then death —the experiences of living creatures obtain in the physical cosmos!

This brings us within the sphere of one of our definite inquiries (for this brief survey does not presume to be a treatise on astronomy; we are only seeking a few facts relevant to the thread of the argument). Has the universe always existed much as we know it now, being only a vast theatre of change, or did it once not exist and had to be brought into being; in other words, was a creative act needed? Materialists of last century unhesitatingly maintained it has been much as it is from eternity and will go on to eternity. Naturally, whatever reply we give to this question, as far as the universe is concerned, must apply equally to the existence of matter. For obviously, if we say that matter, i.e. the constituents or atoms of it, is not eternal in the past, but must have needed a creative act to call it into being as an organized entity, then clearly the universe of the present as such cannot have an eternal past as a "going concern." The two are really one in this respect.

Let us examine this question of origin rather closely. We leave the influence of life out of consideration for the moment, as it will be dealt with when we come to discuss the biological aspects. The surest and simplest way to receive an answer is to take the cosmos as a piece of machinery and trace out what will inevitably happen as the hand of time is laid upon it. I remember as a youth seeing a sundial which bore the inscription "Tempus edax rerum" —literally, "Time, the Eater of Things," or, put more freely, "Time, the All-devourer." Strangely enough this is precisely what the most enlightened science is telling us to-day. We have just seen how our sun is momently pouring out his very substance. The matter in that huge body is being destroyed in the sense that it is being changed into a form of energy: the sun is shedding his substance as radiations. Just as with ourselves, no physical system can "eat its cake and have it too." If it must radiate energy, then, by exactly that amount, it has lost in matter what it had before. But it may be retorted that energy is merely transformed into another form—say light, heat, mechanical work—and energy cannot disappear, it is conserved. Yes, true: but at every change there is a loss in the sense that it is less available. As in life the downward path is fatally easy, and as these changes go on inexorably, more and more energy reaches a lower (or less available) level. A good illustration is provided by a tourist who changes, say, a £1 note immediately on reaching the first country of his tour: he does not buy anything, he merely changes. But he only gets the exact equivalent of 19/6, the missing 6d. he pays for the privilege of the change. The 6d. is not utterly lost, destroyed—they have it at the bureau, but it is for ever lost to the traveller. The 19/6 is changed in the next country and for this our tourist receives 19/-; another change leaves him with 18/-. It would be possible to continue this until our friend is left with but one cent—a cent that is worth nothing in the next country. The £1 has now gone; it has not been spirited away; others have each their little bit of it, but not a cent of the original sum is available to our traveller and the actual buying capacity of it all is nil. So it is with our sun and all the other energy systems in the universe. They are frittering away their energy which, although it may suffer many transformations, is slowly reaching a lower and lower level and becoming less and less available. It is as though an immense fortune were stowed away in an impregnable safe and the key has been lost! So with all the energy in all physical systems; there must inevitably be a time when the universe will have reached one dead level. The energy is all there, but useless. As far as science can tell us, the cosmos will be a vast safe, with unlimited wealth inside, but where is the key?

Now, if all this is true (and it is only one way of stating the second law of thermo-dynamics), the whole of this universe, exhibiting such intense activity, will one day have all its energy "degraded," existing still, but quite useless. Uniformity such as we can scarcely picture would pervade it. If we substitute the word universe for earth, there is no description so terribly realistic as the poem in Genesis about the creation: "And the earth was without form and void, and darkness was upon the face of the deep." Remember, the inertness of it all would be so perfect that we must assume there would not be so much as an erg of energy in the whole of this vast space, that is to say, available energy.

We have reached the point, then, when we realize that at some time, distant yet quite definite, our universe must inevitably come to an end. It seems unthinkable, but there is no escape and this doom is certain. "Change and decay in all around" is exactly the verdict of physical science. Now, whatever pursues an unswerving way to an end must equally have had a beginning: it is impossible to postulate an end without assuming some beginning. There must have been a time when this universe suddenly came into full-blown activity, or there came a faint stirring of energy which was the initiation of the almost inconceivable activity we now find about us. In either case science is dumb and can offer no suggestion as to how the first step arose. It is all very well to say that at some point in this illimitable void there occurred some trivial condensation which differed from all else. There could be no reason for this in a physical sense and reason rebels against it as a gratuitous assumption: the onus of proof, even of its probability, rests with the scientist who predicates so facile an explanation. Thus we are unequivocally driven to the recognition of both beginning and end of the cosmos as it exists at present. We are assured that in its final distribution all this vast energy has reached a condition in which it is impotent and for all the use it would be, may just as well be non-existent. Obviously, as far as physical science is concerned we have reached a complete dead-lock. In the introduction to a classical and remarkable book, devoted to the purely mechanical aspects of biology, one of our most philosophical writers on the subject says, "Matter as such produces nothing, changes nothing, does nothing"[1]—the conclusion at which we have just arrived. One of the most eminent of last century's mathematicians, Clerk Maxwell, used to say that the atom bore all the marks of a manufactured article. Such opinions are worth at least as much respect and ask as much credence as the opinions of those who hold that the physical universe bears within itself all the promise and potency of everything we know. Sir James Jeans has come to the conclusion that the universe is most like a vast thought[1]—the thought, too, of a mathematician. In view of all this, may we not insist upon asking who is the manufacturer, who is the mathematical mind, who is the one who first turned the key when everything was "without form and void"? If there were a sort of mechanical inherency in that great void by which it must inevitably produce the organization which we call matter, as it were in the ordinary course of things, we ought surely to be able to find some trace of this inherency. More than this, if the mechanist could find such trace he would certainly not be long in producing the evidence. His *opinion* alone is not proof. Opposed to these speculative opinions is the fact that with all the wealth of knowledge we possess we know of nothing which is creative save mind. Yet another eminent professor says, "The present tendency is to reduce living organisms to mechanical systems. In view of what is now happening in physics itself it does not seem

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[1] *Growth and Form*, by Prof. D'Arcy Thompson, F.R.S. (p. 14).

universe
as
thought

mind

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[1] *The Universe Around Us*, p. 328. *The Mysterious Universe*, p. 134 and p. 144, etc.

likely that this effort will be successful."[1] This means that there is something even in physics beyond a mere mechanical interpretation. Speaking about the origin of the universe the same writer says, referring to any *physical* explanation of this event, "It is almost incredible, when we reflect that this amazing panorama sprang suddenly into existence a finite time ago. It emerged full-armed, as it were, out of nothing, apparently for the sole purpose of blazing its way to an eternal death. This is the scientific account. It seems to be true as far as it goes, but we cannot believe that is the whole truth."[2] Certainly the Christian has long believed such an interpretation is not the whole truth, and the latest views of the physicists support his belief with no uncertain voice. The conception of God would thus appear to be not only legitimate, but to be demanded if we are to regard the scheme of things as possessing any rationality.

nebular

Of the many other avenues by which we might approach this subject of origins, one more must suffice. It used to be supposed that as our sun has a system of planets revolving about it in orderly array, so also every other star had a similar equipment of orbs to grace its majesty. Assuming that the sun was in a much more nebulous state than now and has gradually condensed, during this process it was believed that each planet was a portion left behind to form a world. Thus arose the worlds forming our solar system. In a similar way, as the various planets condensed they too would leave parts which became their various satellites, e.g. our earth and its moon. If this were the explanation of the way in which our solar system arose, it would appear that much the same thing would happen as other stars cooled and condensed. It would therefore be reasonable to expect that a very large percentage of suns—perhaps millions of them in our universe—would necessarily be attended by a family of planets, and the chances of worlds such as our earth with the capacity of habitability, would be very great. This means that there would probably be countless worlds in the universe.

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[1] Sullivan, *Limitations of Science*, p. 302.

[2] *Loc. cit.*, p. 32.

Recent investigations have shown, however, that the theory just outlined is not only improbable but is mechanically unsound and in its place has been suggested another one which also accounts for the constitution of our solar system much better. The sun is by no means a stationary body, but in common with all stars moves through space, carrying the solar system with it. Some of these stars are moving at very high speeds, yet so vast is the space occupied by our universe that the velocities of stars do not seem to alter the apparent relative positions of them. But it happens with extreme rarity that one sun approaches another, and by the gravitational pull draws out from one of them an enormous amount of matter, which assumes the form of a tremendous spindle or cigar, i.e. narrower at each end. As the oncoming star begins to recede, the spindle-shaped mass

Planetesimal Hypoth

breaks up into a separate family of orbs, the largest ones being in the middle. Thus of our nine planets Jupiter is the largest, and from it, both sunwards and away from it, the planets diminish in size. The point of it all is, that such an event is extremely rare—happening perhaps only a few times in the whole life history of the universe. So far from the formation of a planetary system being a common occurrence it is now recognized and believed to be so rare as to be rather in the nature of a unique event. Assume, however, that our solar system is not the only one by any means in the universe; allow the full possibilities and probabilities; even granting this, we are not near to proving that life such as we know exists in any other solar system. It is very doubtful if any other of our planets has life upon it. Mars would appear to be the only possible candidate for such a distinction, and few present-day astronomers would give any answer but the most guarded and dubious. The so-called canals, which were once regarded by many as evidence of some kind of intelligent activity, may very well be a physical phenomena. The most suggestive fact is the advance of the reddish patches north or south as the polar snows melt—a fact which has been interpreted as due to the growth of some type of vegetation. Even so, it is but a speculative suggestion. On the other hand, the one certainty is this, that however we look at it our solar system is one of very few; which, coupled with the fact that we can discover no evidence of life anywhere, confers a uniqueness on our earth that may not be matched in the whole universe.

If we set down in order the above chain of events they begin to look startling—the approach of two stars (itself an extremely rare event): approach to *exactly* the right distance to draw out materials for planets: no collision (as may well have occurred): the appearance of living creatures on one of these planets and, as far as we can determine, on one only. Each of these appears to be well-nigh unique: the *chances* against any one are very great and therefore, taken together, they are strongly suggestive of some purpose and design. For the moment I simply press the suspicion of some motive in it all, and will now proceed to collect what has been stated anent the cosmos as a physical concern.

First we tried to fathom the nature of Matter and found nothing solid there. Instead we discover a series of extremely complicated group waves — merely emptiness in a hypothetical ether. Atoms are configurations, complicated beyond imagination, but there is no substance, no " stuff " in their make-up. In short, it is the *organization* that is the important feature and not material. These organizations seem to be laws unto themselves, for the mechanics of them differs from matter in the gross. Their immateriality is so striking that we may look upon them as spiritual in nature rather than material. And this is the basis of the whole physical cosmos! As if they would specially emphasize this conclusion, the group waves are found to be guided and controlled by constituent waves, and

atoms
organization
important

NB

this without using any energy of their own. Here is a most remarkable fact, lying in the heart of the building stones of worlds, stars, universes—guidance and control without using any form of energy known to us! Then, by following the process of the running-down or degradation of energy, we saw the universe must inevitably end[1] and therefore, just as inevitably, must have had a beginning. Since we have no hint from science as to how this beginning arose, there remains only the act of a creative Mastermind, and indeed mind is the only creative thing we know: it is the one thing that confers rationality on the universe. Lastly we saw that the method of the birth of the earth is such that we can fairly attribute it to a carefully planned scheme which, on the advent of intelligent beings who can reason about these matters, would logically declare itself to be a purposive scheme and lead by no uncertain path to the Being who devised it all.

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[1] This gradual degradation is called entropy and when it is complete we say the entropy is perfect.

Mind behind it all. Smuts. Science is perhaps the deepest revelation of God to our age.

CHAPTER IV

THE TRANSITION: LIFELESS TO LIVING

In very rapid review we have just covered a few of the facts relevant to the inquiry upon which we are embarked; these facts are culled from the physical sciences, not as our main theme, but more especially to show how strikingly different is the attitude now from that shown by those who were last century occupied with the same branches of knowledge. There are exceptions, but we may confidently say that most of the physicists, astrophysicists, mathematicians, etc., now contend that the universe everywhere bears evidences within itself of the handiwork of a Creator—there has been a mind at work and there still is, whether this be a mathematical mind or not is not of great moment for the present.

Hitherto I have been told (and warned!) that science does not enter seriously into the life and philosophy of a Christian, but to anyone scientifically minded this must be untrue. The question becomes urgent when we consider the thousands upon thousands of young people who are being swayed by a very active minority of scientists whose chief aim appears to be the widest broadcasting of some form of materialistic belief. As bearing out my plea for the value of science to a Christian I quote the following: "Among the human values thus created science ranks with art and religion. In its selfless pursuit of truth, in its vision of order and beauty, it partakes of the quality of both. More and more it is beginning to make a profound æsthetic and religious appeal to thinking people. Indeed, it may fairly be said that science is perhaps the clearest revelation of God to our age."[1] Note that; "the clearest revelation of God"—the words of a profound and cultured scientist—when many biologists are driving home their mechanistic views and pushing the Creator out of His own universe. Still worse is the persistent attitude of those Christians who continue to hold by the falsity that religion has nothing to gain from science. It is no exaggeration to say that science is literally pouring evidence and conviction into the lap of religion if we will but have the vision to see it and the courage to take the gift. "He that hath ears to hear, let him hear." Nor is the passage quoted above something unguarded and alien that has chanced to creep unintentionally into the address, for we find the assertion "We see the mysterious creative rise of the higher out of the lower, the more from the less, the picture within its framework. the spiritual kernel inside the phenomenal integuments of the universe."[1] And again, "The world consists not only of electrons and radiations, but also of souls and aspirations. Beauty and holiness are as much aspects of nature as energy and entropy."[2]

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[1] General the Right Hon. J. C. Smuts in his *Presidential Address to the British Association*, September 1931, p. 14.

The above opening to this chapter provides an apt and convenient transition from the inanimate objects about us to the animate ones. We may begin by asking the age of our earth and when and how life came to be on it, for we have already inquired how the earth and other planets of our solar system arose.

In all these matters we have to be prepared to familiarize ourselves with numbers that are almost unthinkably large—not thousands of years, but thousands of millions. To come then to our own earth. By various methods of calculation, such, for instance, as estimating the length of time which is required for the laying down of the rocks, we can get some idea of the probable age of the earth. The several methods can then be used to check each other. By these means astronomers, geologists, physicists and biologists have reached a reasonably general agreement, and on the whole the age of the earth may be put at some 2,000,000,000 years. Cooling would be proportionately rapid at first; a plastic stage is reached; then a definitely solid outer shell: until finally, some 300,000,000 years ago the earth saw the advent of life. This would at first be at least as simple as the lower forms of creatures known to us now, quite pos-

age of earth

advent of life

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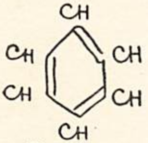
[1] Smuts, *loc. cit.*, p. 18.
[2] Smuts, *loc. cit.*, p. 19.

sibly even simpler. There is no record of such forms in the early geological formations because these mere living specks had no parts that could be permanent and thus they were not preserved. Moreover, the earth's surface would then be much more fluctuating and unstable, and so extinction and destruction would go hand in hand with the instability. However, the earliest traces of life take us back some 300,000,000 years.

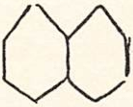
Before we can discuss the nature and characteristics of life we must say a little about the vehicle through which terrestrial life manifests itself. We have already spoken about atoms, but isolated atoms cannot carry life: atoms must join up or combine with each other in very complex ways. These combined atoms are called molecules. Simple examples are table salt (NaCl) or sodium chloride, where one atom of the metal sodium combines with one of chlorine; water is H_2O—two atoms of hydrogen with one of oxygen; alcohol is C_2H_5OH; benzene is C_6H_6 where the six atoms of carbon link up with six of hydrogen and so on. The combinations (or compounds) which all the 92 elements—or different kinds of atom—may form with each other, are relatively simple in their make-up and limited in number—all except carbon. So great is the difference in these two respects that the *known* compounds of carbon are estimated at about 250,000. True, many of these are to some extent laboratory curiosities, but the essential fact for us to grasp now is that this remarkable element enters into

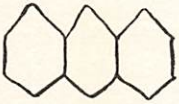
atoms join up molecules

the composition of every particle of living material. So universal is the presence of the carbon atom in living organisms that a biologist cannot even conceive a single living cell without it. There are elements which, *chemically* speaking, are very like carbon—silicon, for instance, is a very near cousin, and on purely theoretical and chemical grounds, one might have thought that here and there silicon might replace carbon; but no single instance of the substitution is known to scientists. Instances of such substitution of one element for another are frequently met with elsewhere. An illustration is furnished in the case of potassium bromide, which is largely used in medicine as a sedative. Sodium bromide, in which the metal potassium is replaced by that of sodium, has exactly the same effect as a sedative, and a goodly list of such instances might be given. It may be remarked that sodium and potassium are related in much the same way as carbon and silicon in their chemical groupings, but what a profound difference when we consider the two in their association with life! The unique position of carbon here is absolutely rigid and complete. No wonder, in his Swarthmore lecture, Sir Arthur Eddington regards carbon as the "mysterious integer six." (It will be recalled that the atomic number of carbon, in the table of elements, is 6.) It *is* mysterious, and one may even venture to say that investigation is never likely to reveal to us why carbon should stand so uniquely alone. The mystery of carbon in its association with life is far more profound than is the mysterious behaviour of radium; for it lies at the very core of the existence of that palpitating, pulsating entity we call life; thence to consciousness and so to mind. We very naturally ask if this is due to chance. The universe and all it contains, according to the Hon. Bertrand Russell (now Lord Russell) is but a "fortuitous concourse of atoms." If in these chance arrangements there had happened to be 91 and not 92 elements, and that carbon had been the one to be "fortuitously" omitted, as it could well have been if dependent on chance alone, what then? It may be replied that some other element might have stumbled across a compound or a few compounds which could have housed some sort of life. Were this possible we might reasonably have expected to find a few sporadic cases where there had been some such attempt. For obviously (postulating a purely mechanical cosmos) the fact of carbon being the chief element in the vehicle of life would not and could not prevent experiments (so to speak) in the like attempt by another element even if it proved to be abortive and never attempted to develop farther than the first crude effort. There is no reason *a priori* why this should not be so. The facts known to us, however, completely negative any such supposition and, as hinted before, carbon stands in majestic and impressive aloofness. Its peculiar capacity is in the way it forms its compounds, which may be in the form of long chains or in the form of closed rings. An example of a carbon chain is fructose—a sugar found in honey, $CH_2(OH)\cdot CH(OH)\cdot CH(OH)\cdot CH(OH)\cdot CO\cdot CH_2\cdot OH$. The simplest closed ring molecule is benzene, which ring may link up with another ring and form naphthalene, or with two and form anthracene, and so on with others. It will thus be seen how complicated a large molecule containing carbon atoms may become. We may write down the benzene molecule in a much shorter way, viz. C_6H_6, but this gives no idea of its structure as does the ring below. When it is added that each carbon atom, instead of holding one hydrogen atom, may hold a short or a long chain, then it becomes evident that theoretically there is scarcely any limit to the complexity of these molecules.



Benzene


Naphthalene


Anthracene

These brief statements have been leading up to the almost unthinkably complex composition of most of the molecules which go to build up a living creature. Thus the white of egg (albumin) is $C_{204}H_{322}N_{52}O_{66}S_2$, while that of the red colouring matter in horse's blood (haemoglobin) is written $C_{680}H_{1098}N_{210}O_{241}S_2$, and in the dog it is $C_{725}H_{1171}N_{194}O_{214}S_2$. In these instances, as in the others belonging to living organisms, it is not the mere size of the molecule (in other words the number of atoms) that is so impressive; it is the organization which appeals to our sense of wonder and also the multifarious variety they exhibit. If again we regard living creatures as mechanical contrivances and nothing more, we should surely be justified in expecting the haemoglobin molecule in dog's blood to be the same as the corresponding molecule in the horse. No machine with which we have any acquaintance would produce this variety. If we try to envisage these variations as machine products (an unattended machine, too) I would point out that experiments with such intricate warp and weft can be very costly—the least misfit in the necessarily delicate and imperative demands of livingness would involve wholesale destruction. This leads me to point out that we have thus far examined only a few salient features in the structure of the atom, some of those involved in the structure of a solar system, and now, at the very threshold of the inquiry into life, the same insistent feature meets us, occurring in all of them. I refer to organization. More than this, down in the very heart of the structure of matter we find guidance at work. I have already quoted Sir Oliver Lodge as responsible for this arresting statement. If I stress this notion of guidance by pointing out that it pervades the whole of nature (as we shall see), it is because we begin, on the authority of the physicists, with an impregnable rock on which to build. Let me quote a passage from another unimpeachable authority who is speaking about the attitude of physicists to-day compared with that of some forty years ago. " No physicists would then have dared, as now, to cast doubt on the sole sway of determinism in the physical world. . . . None would have questioned, as now, the universal truth of the second law of thermodynamics. None would have ventured, as now, to suppose that electrons change in the very act of becoming known to us, and that therefore the mental factor is ultimately inseparable from physical investigations. None would have dared, as now, to conjecture that particles of matter correspond in their properties to certain group waves of the ether, the constituent waves of which 'guide' and 'direct' the group waves without any energy of their own."[1] It will be noticed that the *fact* of guidance and control without the expenditure, apparently, of any energy is here stated in the almost identical words used by Sir Oliver Lodge. Is it possible to find anything which more convincingly suggests the action of mind? To my own thinking, it is one of those coercive facts which have a habit of springing a surprise on us the more we study nature. Like the proverbial ghost of the old manor house, they will not be "laid."

We have now reached the point where we can visualize atoms being built up into very complicated molecules. Some of these may consist of somewhere in the region of 20,000 atoms. Even then these molecules are beyond the limit of vision of the best microscope and their structure has to be investigated by other means. Now living organisms always have their chief bulk built up of these complex molecules. But this is not to say that if we could experimentally build up similar or even identical aggregations of molecules that the structure would necessarily be alive; indeed, with all the wonderful resources at our command to-day, no one has so far succeeded in making any dead material, however complex, exhibit the remotest sign of life. The material, in the bulk, which has the capacity to live and is always associated with living creatures is called protoplasm. Long ago T. H. Huxley called this protoplasm "the physical basis of life," and whether we adopt a materialistic and mechanistic way of regarding life itself, or contend that the machine-like working of it is but a very superficial aspect and that the real secret lies much deeper and beyond, all agree that protoplasm *is* the physical basis of terrestrial life. This, therefore, is the common ground upon which we stand: the fact is assured, although the meaning and interpretation differ profoundly among different authorities: eminent ones disagree with the mechanistic view—a view which does not carry us to the root of the problem. "Thus, although many discoveries have been made about the nature of protoplasm in the last few years, they seem, by enlarging the scope and changing the method of attack, to have placed the final understanding of this problem still further from our grasp."[1] Once more we read, "In spite of the more or less precise way in which we can now visualize the details of the process of living, the student

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[1] *On the Nature of Mind*, by Chas. S. Myers, M.D., Sc.D., F.R.S., Sectional Address to the British Association, p. 4. London, 1931.

bulk in which life is found - protoplasm should be careful not to confuse this with the metaphysical hypothesis, which *assumes* that the details are all that there is, and which is known as the mechanistic view of life as distinguished from the vitalistic view. Life may be something much more wonderful and sublime than even the most complex and highly co-ordinated living mechanism."[1]

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[1] Whitfield and Wood, *Introduction to Comparative Zoology*, p. 3.

We are now face to face with the inquiry whether life is just a more complicated interplay of chemical and physical manifestations, or is it something entirely different from chemical reactions and physical changes? In other words, is the difference between the animate and inanimate one of mere degree, or is it a difference in actual quality? The one quotation above warns us that by prosecuting our inquiry solely in the mechanical direction, the final explanation appears to recede " further from our grasp." So far, it has proved to be unsatisfying, we drift farther away from the essential point at issue, and instead of telling us what life is, it gives us only the description of a process. The other (the second one) frankly and boldly tells us that as an " explanation " the mechanistic view is simply an assumption and that instead of a bundle of physical energies, life is far more likely to be, not only more wonderful than the most intricate machine, but more sublime. Both the above works are avowedly descriptive, and if they are not of set purpose dealing with the problem of the nature of life, their scope is mechanistic just because they are solely descrip-

Life
matter of
degree
or
quality
?

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[1] Small, *Textbook of Botany*, p. 420.

tive. Yet they have this in common, that they are careful to add that they have not "explained" life and consequently on this matter they have not spoken the last word. The one thing that does emerge is this, that whatever opinion we form, the purely materialistic view is incomplete and only partial: but while the mechanistic pursuit is legitimate and proper as far as it goes, it must be content with recognizing that its limitations are strict. It is this fact that mechanism is not "the whole truth and nothing but the truth" that is at once its menace and its danger.

It will be noticed that the above authorities are, as it were, negative in their contentions, i.e. they tell us what mechanism cannot achieve. We may profitably note another who gives us a more positive view—more constructive for our purpose. Dr. Borradaile, in the introduction to his work on Zoology, says, "Objects are alive when we observe that they take action—that they 'do things'—and further, that the things which each of them does are such as should be beneficial to it and to its own kind." Emphasis is laid upon this on page 2: "A living being is always in action for the good of itself or its race. This fending for itself and its kind is life." It is quite conceivable that the mechanist may retort—Yes, but there are many objects in the inanimate world that "do things." Thus, radium gives off its three so-called emanations and displays a remarkable energy in the process. These are, helium atoms (the α rays); electrons (β rays); radiations, in other words vibrations,

(γ rays). These alpha, beta and gamma rays are characteristic of radium and its class of elements. When heat is applied to water steam is produced and this steam may " do things "—drive a locomotive or a liner, or if inside the earth may crumple the crust or surface of it. A shell when it explodes " does things," usually very terrible ones. But in all these instances there are two characteristics: firstly, the energy for the process is supplied from without; secondly, there is always disintegration and dissipation of energy, which means that this energy is on the downward road of which I have already spoken. In fact, these are just particular examples of the inevitable tendency of the universe towards its doom as a physical system. It will be observed that in all this there is nothing reproductive or even conservative about the processes—conservative in the sense of preserving the availability of the energy. It is true that in any specific instance the loss may be small, but it is always there, and by using exact and delicate methods, it is definitely measurable. With living things it is not so, the energy is supplied from within, and except for some accidental and outside disruption, such as lack of food or mechanical destruction, there is not only no delimitation of the energy, but it is actually handed on in increasing volume by reproduction and in a less degree by growth. Put in a more positive way, life differs from all other processes by its energy being liberated *at will* in such a way as to make for the preservation and increase of the thing in which it is going on, that is, in the organism. Not only so, in the highest organisms, such as human beings, the purposiveness is both conscious and entirely directive. Even among lower organisms I am inclined to think this is true to a lesser and varying extent. At all events, a living creature is always in action for the good of itself or its race. Can we say this of any single physical inanimate object? Does a radium atom break down for its own good or for the good of other atoms? Does a shell explode that it may advantage itself or benefit its fellows? A positive reply would be absurd. But the questions emphasize the fact that living beings are radically different from all other organic or inorganic nature—not in degree, let it be noted, but in actual quality.

We must now look rather closely into the essential structure of living organisms, and thus be in a better position to confirm what has just been said by a wider knowledge of these life processes.

CHAPTER V

LIVING CELLS AT WORK

HAVING got some little notion about the chief component of living organisms, we must proceed to inquire what are the characteristic features of this protoplasm as it is found actually at work. It would be a mistake to suppose that carbon, although it is the great essential, is the only element necessary to complete the manifestations of life. Mineral salts, such as chlorides, phosphorus, nitrogen, sulphur, water and a few others have all important parts to play —water in particular bulks largely.

Now the unit which the biologist adopts is the cell; it plays an analogous part in all his studies and his theories to the atom of the physicist. This does not mean that the biologists ignore the existence of atoms: it is simply that their building stones must reach a certain complexity of structure by being composed of myriads of atoms, organized in a very definite way, before they become useful to him. Once more, organization becomes imperative before we can so much as make a beginning. It may be remarked here that it is quite possible that

Cell — composed of atoms

the class of bodies known as filterable viruses may be living units, but, being beyond the ken of the microscope, we cannot say whether or not they have a definite structure similar to the cell—the main difference being their ultra-microscopic size. For instance, the germ causing measles has never been seen, yet it is plainly a fact that some infective body (probably living) is responsible, differing, say, from the diphtheria germ in that it is invisible. Bearing this possibility in mind, we may return to the visible unit, the cell, since the existence of even smaller organisms will not affect the argument.

Virus may contain life - measles germ

Living creatures may be so sharply circumscribed that all their activities are confined within the limits of one cell; or they may consist of a few which combine and pool their energies and resources for the common good; or there may be many thousands so combined; and lastly there may be millions upon millions. As the number of cells composing the organism increases there arises the need for some sort of division of labour among them, and hence we find various types of specialization (differentiation, it is called by biologists) by which some cells assume one function, some another. Thus it comes about that, in the highest organisms, we reach such astonishing modifications as skin (or a hard shell, as in crabs, lobsters, shrimps, many insects), bone, muscle, lungs, glands, stomach and intestine, nervous system (culminating in a centralized brain) and so on. We are so accustomed to this as an everyday process that we never pause to think of the continued

Division of labor

miracle unfolding itself before our eyes. Yet even a human being (as will be discussed later) begins its career as one cell—or more strictly, the fusion of two cells, male and female, into one.

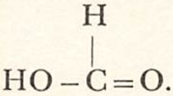
What, then, is this cell which is every whit as marvellous and thought-provoking as a whole universe? It is at least as unique in the cosmos as a solar system, probably a great deal more so. Moreover, if the physicist feels impelled to say that even an atom bears the marks of a manufactured article, or that the physical universe is like a great thought and more explicitly the thought of a mathematician, how can we escape the conclusion that, somehow or another, a *living* agent must at least equally so be responsible for the living cell? To admit the one and deny the other would appear to be a logical confusion and take all the rationality out of the cosmic scheme. A mechanistic biologist would probably dismiss the physicist's conclusion, but is he or the physicist more likely to be right in solving a physical problem? Apart from any direct biological evidence, therefore, we can at all events take our stand on the physicist's platform and claim a patient hearing while we proceed to examine closely a number of biological problems which have the same sort of bearing on the general theme as the mathematician's have on the physical universe.

While the cell is fundamentally the same in plants and animals, there are two points of difference in the structure to which attention may be drawn. These differences, it must be

Plant & animal cells
2 points of difference

said, are not absolute—there are border-line instances where it is not easy to decide readily to which great class a given cell should be
1. referred. In the first place, speaking broadly, plant cells are composed of protoplasm which is limited by a definite cell wall. This wall is not living material, only the protoplasm within
2 functions as living. In the second place, plants in general are characterized by green bodies within their leaves. The fungi form a remarkable exception, but on the whole the statement remains true. The green material occurs in very small bodies called chloroplasts: the green material is chlorophyll. The chloroplasts with their chlorophyll are the most fundamental things in the whole of animate nature—without them, life, in the forms we know, could not exist on this earth. A very brief explanation must be attempted. It will be remembered that light is a form of energy: sunlight is the great activating primal source of our earth's energy. Chlorophyll has the remarkable and basic property of specially gathering in and storing this sunlight energy—it is an immense reservoir. How is it used? The atmosphere, consisting almost entirely of oxygen and nitrogen, contains very small quantities of other gases, among which is carbon dioxide (CO_2). Animals breathe this out as a waste product and therefore it would tend to increase in amount until it reached a destructive percentage. Here comes in the function of the chlorophyll, which extracts the CO_2 from the air, breaks it down into carbon and oxygen, retains the carbon within the leaf

cells, discards the oxygen which goes back into the air. Animals do not want the CO_2, but the oxygen is vitally needed. Thus, by the insignificant-looking chlorophyll, the marvellous and basic balance is maintained. Yet this is only the beginning of the story. The retained carbon, in the form of atoms, is not much use as such, though the energy of the sunlight in the chloroplasts has done this vital preliminary work. The carbon is therefore acted upon and possibly first becomes formaldehyde and then formic acid, which, written structurally, is



$$\mathrm{HO}-\overset{\overset{\mathrm{H}}{|}}{\mathrm{C}}=\mathrm{O}.$$

It is not necessary to pursue the chemical aspect of this, for the point I want to emphasize is that here we have the first step in the formation of the long chains of carbon atoms to which I have referred and which are built up more and more into molecules of various sugars and starches. Now all life in the animal world depends ultimately on these types of food: no animal can manufacture them for itself, and thus every animal depends on vegetation for its existence. Even the so-called flesh-eaters are ultimately vegetarian—the tiger kills and eats a sheep, which in turn lived on grass. "All flesh is grass" is a very literal summary. I need not press home the arresting way in which these two classes of fact dove-tail into each other. The mechanist would retort that the adaptation is purely the result of blind and ceaseless struggle, but too much of this kind of thing pervades the whole of the cosmic scheme, not merely an isolated instance here and there, to be curtly dismissed in this way. Speaking on this very subject, a late professor in the forefront of biology said, "The ordered beauty of the world of Nature suggests an infinite intelligence with powers of action such as no man or other creature possesses, and evolution which was so hotly contested by the theologians of a generation ago, suggests the beautiful conception of continued action."[1]

Having said this much about a plant cell as distinguished from an animal one, and bearing in mind the above reservations, we proceed to gather a few salient facts about the animal cell, since it is the zoological side of biology, rather than the botanical with which we shall now be mainly concerned.

In a typical one-celled animal organism there is usually no outer wall or skin to limit its movements—at least it is not obvious. The substance is a sort of semi-fluid jelly, and two separate parts may readily be seen. The whole of it is protoplasm of course, but for distinction's sake the outer part is called the cytoplasm and within this, usually, but by no means always near the middle, lies the remarkable structure known as the nucleus or kernel. This too is semi-fluid but is shut off from the cytoplasm by a very delicate membrane. Apart from the bodies to be mentioned immediately, the cytoplasm, under high powers of the microscope, appears to be quite structureless, containing one or more globules of a more watery character (called vacuoles) which pulsate slowly as though they might be breathing organs or a heart slowly beating. At times they discharge their fluid and then slowly grow to normal size again. Particles of food are digested in other vacuoles and the waste is then put out or excreted. Other bodies are present from time to time, such as fat droplets and food particles, starch granules, glycogen, small granules in gland cells, all of which are non-living, but ready to be built up into the living cell (except the last). Other bodies present are actually living, such as plastids, which become the chloroplasts already mentioned and which are common in plants although they *do* occur in a few animals such as the plant-animal, Convoluta, a small planarian worm. There are the mitochondria, the finest of threads (or sometimes thicker and oval), which circulate freely throughout the cytoplasm. They are associated with intense chemical activity. Then there is the Golgi apparatus, a dense fine network, suggesting a very fine piece of string rolled and mixed up at random, which occurs usually in a gland cell and is associated with the manufacture of the gland secretion, e.g. saliva, gastric juice. This apparatus occurs also in nerve cells. These details have been given mainly with the view of showing how marvellously intricate is the structure of the outer part of a cell. This outer part, the cytoplasm, necessarily has all the movements to perform, and it does so by slowly flowing, as thick treacle or pitch might do, by pushing out

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[1] The late Prof. Benjamin Moore, *The Origin and Nature of Life*, p. 23.

Vacuoles

amoeba

1. moves
2. takes in food
3 gives off waste products
4. takes up oxygen

Summary

protrusions of its substance and drawing itself forward. These are the pseudopodia (false feet). Thus, except in certain resting stages this lowly animal, for example an amoeba, is continually changing its shape. Should it encounter a food particle—perhaps a bacillus or other germ—a protrusion slowly passes round it and engulfs it. Digestion then proceeds and the waste products are afterwards passed out by reversing the process. The cytoplasm also takes up the oxygen needed for respiration. The amoeba, to which the above description mainly applies, has a first cousin living in human blood, known as the white corpuscles. Their capacity for devouring germs makes them a valuable ally in many forms of infectious diseases, for they can pass through the blood-vessel walls and take their stand, like an army, among the affected tissues. Here, then, is a tiny organism which moves without limbs, eats without mouth and digests without stomach, contracts without muscles, breathes without lungs, excretes without kidneys, immediately rejects particles which are not food or which are harmful and continually carries on that cunning and mysterious process that we call living! When we consider all these functions, associated within a microscopic bit of jelly living in a ditch, all of them co-ordinated accurately towards one end, we must surely feel that we are in the presence of something more than a bit of physical machinery. However, before drawing any definite conclusions, there still remains a brief consideration of a much more wonderful structure that resides nucleus

within this cell: it is the nucleus and is responsible for the direction of this minute economy and also for the perpetuation of the species.

Surrounded as we are on every hand by marvels, it is doubtful if the whole range of nature can show us anything more wonderful than the nucleus of a single cell. Unlike the cytoplasm of the cell, it is not concerned with what may be called the actual housekeeping arrangements—providing food, the respiration, disposal of waste and so on—these are done by the outer part. Instead, it assumes control, and the control is such that, speaking generally, cells cease to live if they are despoiled of their nuclei. (There are exceptions in lowlier organisms where nuclei do not appear to exist, but many, if not all, are only apparent exceptions. The function of the nucleus in these seems to be subserved by a multitude of tiny particles distributed over the whole cell instead of being gathered into one definite centre.) The changes about to be described are characteristic of all cells, whether one cell is a complete independent animal (or plant), or whether the organisms are built up of a few hundreds, or many thousands or millions. They can be watched under the microscope in the tips of growing roots or plant stems, in the skin of newts and salamanders, in developing eggs, and in fact in any accessible growing tissue; indeed bits of living tissue can be kept growing in suitable fluids even for years and all the processes followed step by step. For descriptive purposes we begin with a cell in the resting stage.

Nucleus
small ball
tangled thread
centrosomes
2 tiny spots
retreating
throwing off
rays
break up into
rods (chromosomes)
color bodies
each a linked
pair

Division of a
cell

The nucleus looks like a small ball the interior of which is occupied by an irregular network. Very soon the network appears more like a very fine thread coiled up without any order, entangled as it were in a hopeless fashion. Two tiny spots appear close together and begin to retreat from each other (the centrosomes) towards opposite ends of the nucleus, throwing out rays like a star as they go. Some of the rays of one centrosome are linked up with some from the other, so that the appearance is that of a very fine spindle passing through the nucleus. Meantime the skein of entangled thread is seen to be breaking up across its length into a number of rods. The number of rods is *always* constant for each species of animal or plant; in one of the worms there are only two, in others there may be some 200, while in man it is 48. The number is an even one—we shall see why in a moment. These rods are called chromosomes, a word meaning colour bodies, because they are bodies which stain very vividly when treated with certain dyes. The skein, then, has now broken up into its own appropriate number of rods for the species we are watching. To simplify matters, suppose we are looking at the egg of a worm which has four rods. It is now found that each rod is in reality double and there are strictly speaking eight rods which are arranged (still in linked pairs) in a more or less haphazard fashion about the nucleus. This quickly gives way to a definite order, for the rods now move to the part of the nucleus midway between the two stars (which are at the two poles) and hence they lie on what is called the equator. The remarkable feature is that the threads of the spindle seem to be responsible for the arrangement. When the rods reach the equator (they are now double and in reality there are eight of them) four half rods are taken charge of by spindle threads and are drawn towards one pole. That is, four go towards one centrosome and four to the other, *guided* by the spindle threads. A constriction appears at the equator as though a string were being tied round it, until finally the two halves are separated. The same thing happens to the body of the whole cell, half the cytoplasm going to the right, half to the left. Consequently we have now two separate and complete cells where there was but one before, each with its full complement of four chromosomes. These merge into a skein, the new cell begins to take in food and grow, only to repeat the process again. There is no such thing as death; amoebae living to-day have an unbroken ancestry away to the first on the earth, perhaps some 300,000,000 years ago. We shall presently come to the significance of this. Once again we come face to face with the insistent fact of guidance and it is already becoming far from easy to understand its meaning on a purely mechanistic interpretation.

It must be realized that only a very abbreviated account of the division of a cell has been possible, but it has behind it a number of significant features. Speaking generally, the whole process admits of but little variation. Even a small deviation would result in the mechanism being thrown out of gear, so delicately exact is the process. The points to which I want now to direct special attention are: 1. The exact division of the chromosomes so that each daughter cell shall receive just half of each one, neither more nor less. If this were not so the two daughter cells would be different and would also differ from the parent cell. It is a question of accurate equipartition of chromosomal substance, and obviously it must be so if any species of animal or plant is to preserve its identity; otherwise a few generations would throw every species into the most hopeless and chaotic confusion, and there could have been no such thing as evolution. 2. It will be allowed that the spindle arrangement is not only a very beautiful one and must excite any observer's admiration, but it is also exact in its working and almost unthinkably delicate in its adjustment. Failure on the part of one thread of the spindle would again result in a failure of that essential equipartition, a condition which must be unswervingly fulfilled. Thus we find these remarkable events conform to all the other ordered sequences in nature.

It may be asked, however, if there ever is any deviation from this course which appears to demand such unquestioning obedience. Strange to say, there is a very outstanding instance well known in medicine where cells do not, when dividing, follow the plan outlined above. In healthy individuals and in healthy tissues the usual course admits of no exception. It will be remembered that a human cell has 48 chromosomes which really exist in pairs although they appear to be single until the cell begins to divide. Notably in one condition, however, in addition to the ordinary spindle, with its star (which is called the " aster ") at each pole, a third pole appears and from this spindle threads pass. This is not all, for the alien threads exert their mechanical influence and take a proportion of chromosomes. It might be thought that each aster would claim just its share of the 48 chromosomes, that is, 16 of them would be guided off to each pole. Not so; for, as if to accentuate the faultiness all the more, the division, too, is irregular and we may find 20 chromosomes at one pole, 16 at another and 12 at the third. What is the meaning of this strange behaviour? Only one thing: such irregular division never occurs except in malignant tumours (cancer, sarcoma and the like) and as everyone knows only too well, malignant tumours are infallibly destructive of the persons (or animals) in whom they occur—that is, unless removed at an early stage. All of which means that irregular cell division, deviation from the strict usual course, implies only one thing, and that is, self-destruction.

Suppose for a moment we look upon the whole scheme of things, the universe and all it contains, as mechanical, without Creator, without guidance. The time arrives when the mechanical conditions determine that cells are due to appear. There is nothing to decide how many chromosomes shall appear—it is pure chance and as likely as not they would be odd in number—3, 5, 19 and so on. Now this would not matter a great deal, *per se,* for lowly organisms, but the moment any higher development was attempted in the direction of the evolution of sex, this would be a sheer impossibility. For before sex is possible the number of chromosomes in the male and female sex cells (sperms and ova) has to be reduced exactly to half, and this would obviously be impossible where 3, 5, 9, 17, chromosomes existed. Thus the animate world would have been rigidly restricted to lowly asexual organisms; nothing higher could have been remotely possible. It may be countered that even numbers of chromosomes would exist in, roughly, half the original cells and so have allowed sex to develop in those. The reply is that this selective process would not begin to operate until sex *did* appear. Before that time the odd-numbered chromosomal cells would have precisely the same chance of survival as the even-numbered, and the fact of sex appearing would not and could not have any effect towards eliminating these odd-numbered ones—they would continue to exist alongside the others, but would simply not evolve to the higher type. We ought therefore to find, below the sex appearance mark, an equal number (approximately) of organisms with odd and even numbers of chromosomes. As a biological fact we find nothing of the kind, which to my mind effectively disposes of the supposition of a *chance* appearance of chromosomes into the animate world. It seems difficult to think of any great fact which more clearly demonstrates intention, design, purpose. It is in whole-hearted agreement with the astronomers' demand for a mathematical mind—an Architect who has thought out the whole scheme before ever a line, so to speak, was "put on paper."

There is one other consideration with respect to the spindle before we pass on to an examination of the creation of this marvellous life. The lowest forms of life, as far as we know, have no orderly arrangement that can be called a nucleus and hence have neither definite chromosomes nor spindle. We may regard the scattered particles in certain bacteria, etc., as consisting in reality of the foundations of a complete unitary nucleus. We know of no organism intermediate between these and cells with a fully-fledged equipment of chromosomes *and* spindle. Did such ever exist? If they did they have left no trace in the shape of survivals. While it is freely admitted the ordinary cell is a vast advance on the bacteria without nuclei, would the necessary intermediate form be an advance on the still lowlier type? If it *would* have a survival value, why has it completely disappeared and left the lower type to persist: if it had *no* survival value in the intermediate form, it would promptly be eliminated by the inexorable mechanistic decree "survival of the fittest." Placed on the horns of such a dilemma, there remains but one other alternative, which is, that the whole of these two elaborate processes (the appearance of spindles and chromosomes) appeared simultaneously and chanced to be exactly fitted to supplement each other perfectly. This is precisely on all fours with Sullivan's remark about the creation of the physical universe referred to on p. 36. We may recall his words, " we cannot believe that is the whole truth." The chances of such a vital movement happening fortuitously must be millions of millions to one against it, and it seems to me much more of a violation of reason to invoke such an explanation than to assume a Deity who guides all. For we must remember that so elaborate a piece of machinery as the spindle admits of no half measures—it must appear " full-armed, as it were, out of nothing," to use Sullivan's words. A trial thread of a spindle here and there would be worse than useless, leading to chaos, malignancy and destruction, as we have just seen, and the trial would immediately end.

The difficulties in the way of a solution of such problems as these would seem to be insuperable by a mechanistic or a " chance " philosophy, and we are only blinding our eyes to the difficulties by refusing to see a Master Mind at work—a Mind watching, leading, directing; one which is (if I may adopt and adapt the noble expression quoted by Prof. D'Arcy Thompson) " conterminous with space and coeval with time." Nothing happens by mere accident or chance, and the more deeply we probe and delve, the more evident does this truth become.

CHAPTER VI

ON ORIGINS

THE discussion in the last chapter brings us to the inquiry, how did life begin on this planet? Two suggestions last century gained a certain amount of popularity. One theory, due to Lord Kelvin, supposed that the lowest forms of life might well exist for very long periods of time on the surface and in the crevices of meteorites out in space. When these come within the sphere of the earth's gravitational pull, most of them are vaporized by the intense heat set up by friction in passing through our atmosphere. Some few escape complete destruction and arrive in a solid state with primitive life still on them. These were the beginnings. The second assumed that germs may be attached to particles of cosmic dust and some of these may reach the earth through the pressure of light upon them. (Light *does* exert pressure.) There is no evidence whatever for either theory, and besides, they only remove the problem farther away and do not solve it. We are left, then, with one of two possibilities: 1. Life is a distinct creative act; it is an attribute of and a gift from the Infinite mind who has already given us some inkling of his existence. 2. As the earth cooled from its molten state, there would come a time when the conditions of temperature, moisture and so on would allow the *possibility* of living creatures. It is contended that chemical and physical conditions would then be appropriately active for the production of complex molecules which by fortuitous combinations, after much trial and error, would eventually hit upon something that would become more and more an approach to what we now recognize as livingness: thus the first real organisms were begotten. In support of this and presumably as evidence, we are told it must have been so, there was no other way. It is in fact a refined and differently clothed version of the late popular theory of spontaneous generation. It is a very old theory and down even to late medieval times it was claimed that frogs, newts and other highly organized creatures could be produced by suitable mixtures of herbs, etc., shut up in various cavities, etc. During last century this question received a great deal of attention and was attacked in a thoroughly modern scientific fashion. The problem is, if we take a number of tubes containing water, some organic substance such as hay or beef, which most probably swarms with the germs of life or even organisms fully alive, can we, by first destroying every vestige of this life, produce *anew* any form of living organism by exposing the tubes to conditions which appear most suitable for such generation? It was realized that we must be convinced that every trace of life is destroyed, and since ordinary air (except at great altitudes) swarms with microscopic life, this must be excluded. There must be no mistake here.

The procedure is as follows. A number of glass tubes are partially filled with an infusion of hay or with a meat broth. They are now subjected to prolonged boiling so that all microorganisms as well as their spores are beyond doubt destroyed. The tubes are straightway sealed by melting their mouths in a bunsen flame. On cooling, some are exposed to direct sunlight, others to diffused sunlight, and kept for weeks or months. The tubes, of course, contain organic material and salts, moisture, a little oxygen, and are kept at an optimum temperature. Both Pasteur and Tyndall conducted these experiments repeatedly, but in no single case, where the tube remained intact, did life of any kind develop. In a few tubes, it is true, life was found, but *in every instance* it was found the tube was not perfectly sealed or had been cracked subsequent to sealing. So rigorous were the experiments, so invariable the results, that no serious attempt has been made on these lines, except by Dr. Bastian, since these experiments were concluded. The scientific world was then satisfied that Harvey's dictum remained true, *omne vivum ex vivo*—freely translated, everything living comes from something living.

There is no need to set out Dr. Bastian's experiments in full. His basic claim was that he had generated yeast-like organisms by using a silicon compound and also an iron salt, the iron salt (the pernitrate) giving better results. Following his directions exactly I repeated them in 1907 to 1910: other observers have done the same, but not one successful result has been reported. When we consider the character of his solutions this is not strange, for there was no carbon whatsoever in his tubes, and we have already seen that no form of living organism is known to biology that does not contain carbon atoms and it would therefore appear that the attempts were foredoomed to failure.

When we look back on these modern efforts to prove spontaneous generation it must be admitted we have so far dismally failed. In spite of this, especially since 1912, we are continually being assured that we are on the eve of success. That year, before the British Association, Sir A. E. Schäfer, in his presidential address, was particularly sanguine, and the same assurance is regularly being given, together with the promise of the full disclosure of what life really *is*. True, every year adds enormously to our knowledge *about* life, but the central problem is as elusive as ever so far as its solution is concerned. The mechanistic biologist tells us that to believe nature seems jealous and still guards her secret is a defeatist attitude and this only strangles research. Not a bit of it. There is no quarrel whatever with any or every attempt to solve the problem of what life *is* and even to produce it *de novo*: these are quite legitimate biological pursuits. On the other hand, there is quite a danger of toying with an idea until the mere idea itself assumes a real verity. So it would seem to have been with some biologists

—they have been believing that next year, or the year after, someone will have accomplished the feat of spontaneous generation; and so certain is this *belief* (and hope, it may be added) that already to them it is a demonstrated fact. We do well to reflect that " matter as such produces nothing, changes nothing, does nothing " (see above, p. 34) and take to heart the considered view of Smuts on pp. 42-3. Then there are biologists who, so far from countenancing such a facile view, contend that our increasing store of knowledge has only removed the solution of the enigma " further from our grasp " and that life is something " much more wonderful and sublime " than bits of machinery, however cunningly the parts may be assembled. (p. 51.)

Now all this is not to say that we rely on such a statement as " spontaneous generation is not a proved fact, at present " and that if it were accomplished we should be compelled to abandon the belief in God and replace it by the mechanistic conception. If it were announced while these words are actually being penned that some biologist had at last succeeded in producing life, would that have removed the mystery of what it is? Not in the least; the intrinsic mystery would be as great as ever. The experimenter would have discovered a process and that is all. He would have brought together a number of things which are already circumstanced; but he would not have produced the complex molecules in his laboratory from the pristine atoms, he would not have impressed upon them their capacity for cohesion, nor endowed them with the surface tension they must possess, and so with all their other properties. These are all ready to hand for him, and if haply he finds a way of producing life he still lacks all the power of actual creation. We may as well affirm that a gardener who produces strawberries or apples has created them.

We may here refer to the statement of an authority who has had a very considerable influence upon the moulding of people's thought and examine what he has to say. He tells his hearers and his readers, "I have spoken of 'life as a web on the loom of time.' Who, then, is in charge of the loom? Who is the weaver? As far as biologists can perceive, the loom works automatically; the threads spin themselves. . . . Biologists do not know as yet how life began; they have no explanation to offer of its inner significance and ultimate meaning. Their primary business is to observe happenings and give a truthful record of them. Therein lies the weakness of their philosophy, for man's mind craves for a solution of the great mystery and is restless until it is satisfied as to his place in the great scheme of the universe."[1] There is no subtlety here, no attempt at gilding the pill. The author leaves us in no doubt as to his convictions. There are those who prefer the subtle thrust, a thrust designed to wound less during its initial penetration, but we are bluntly assured "the loom works automatically; the threads spin themselves." This, being interpreted, plainly affirms there is no God (or weaver); there is neither guidance nor design, for the threads spin themselves. Yet the remarkable thing is, that everywhere we cast our glance we find nothing but pattern. Some may consider a proportion of the pattern to be rather indifferent, yet it *is* pattern, and the pattern is writ large on the face of the whole "web" when it is woven. There appears to be no doubt about the principle of guidance being a necessary factor in the development of the physical cosmos, and physicists have been the first to point out this remarkable truth. One may be forgiven for thinking that if the principle of guidance were a necessary condition pervading the inorganic and inanimate world, it would at least be as much needed in the organic and animate one. However, we may note that this quotation makes exactly the same untrue assumption as the earlier reference including *all* medical men as subscribing to the author's views, for we read above, "as far as biologists can perceive," which as it stands without qualification would imply that no biologist has any option but to accept a materialistic and mechanistic interpretation. That this mechanistic theory is not adopted by all biologists must be clear from references already given, although these are far from being exhaustive. They are indeed rather representative of a growing number of the best authorities who seem anxious to disown the mechanical theory. As a good example, in an excellent work by an acknowledged authority, we read: "Thus, however paradoxical it may sound, the study of the 'mechanics of development' (Entwicklungsmechanik) leads away from the mechanistic conception of the organism and therefore of life itself."[1] Again, while speaking of the fertilization of the ovum by the sperm, he says, "The feasibility of such a fusion reveals the presence of a specific organismic faculty which, in the last analysis, cannot be referred to any organization either mechanistically or morphologically explicable."[2] It would appear, then, that responsible authorities and investigators are already recognizing that the mechanistic steed has been ridden too hard. Take another considered opinion which is just as explicit; "Evolution is not a deterministic machine, and creative evolution, as we shall see, is far from being mechanistic—on the contrary, it is peculiarly indeterminate throughout all its phases."[3] Once more, referring to a recent work on the one-celled organisms, primitive and microscopic, we find the author affirms, "The concepts of Organization and Vitality give us a basis for an estimate of the nature of life, but they do not tell us what life is."[4] In the preface to this work he quotes:

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[1] Sir Arthur Keith in *Darwinism and What It Implies*, pp. 29, 30.

> Lies dieses Buch, und lern dabey
> Wie gros Gott auch im Kleinem sey,

which is:

> Read in this book and learn therefrom
> How God is also great in little things.

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[1] Prof. Dürken, *Experimental Analysis of Development*, p. 280.

[2] *Loc. cit.*, p. 62.

[3] C. C. Hurst, D.Sc., Ph.D., *The Mechanics of Creative Evolution*, p. xv.

[4] Gary N. Calkins, *The Smallest Living Things*, p. 34.

It will probably be allowed, in view of the opinions just quoted, which could be multiplied, that Sir Arthur Keith's claim to a perfectly unanimous view among biologists is not even near the truth. Since a very great majority of the readers of the above lecture will not be in a position to verify the statement or venture to controvert it, the gratuitous assumption implied may as well be definitely laid bare. It is not that wilful misrepresentation is suggested—far from it; but it is easy for enthusiasm to carry a speaker away and so allow exactitude to be sacrificed.

We may now look a little farther. "Biologists do not know as yet how life began; they have no explanation to offer of its inner significance and ultimate meaning." Very well, if biologists do not know how life began, are they in a position to say (in spite of all attempts to discover a method of spontaneous generation) that it still *must* have appeared by the interplay of chemical and physical energy in what chanced to be a suitable environment? Or are they in a position to maintain that it was *not* a creative act? Now no modern biologist can deny the *possibility* of the appearance of those elaborate colloidal molecules which do go to the making of protoplasm, but as already pointed out, the mystery of livingness is still there. On the other hand, what knowledge we so far have tells us that life is always the precursor of life. Once more, it is now widely agreed that mind is the only creative agency we know. The special point I want to stress at this juncture is just the fact that the mechanistic biologist is ready to examine any suggestion anent the origin of life as long as it does not involve a creative act. Our quotation, however, relentlessly goes on to limit the business of the biologist to accurate observation, adding, " Therein lies the weakness of their philosophy, for man's mind craves for a solution of the great mystery." Yet if the mechanistic theory be correct there is very little mystery left. We have merely to pursue the mechanical acts and manifestations associated with living beings to their ends and there is no further mystery to be found and hence no explanation need be sought. Yet surely the fact that so much *does* await investigation and explanation is enough to suggest that life is something more than mechanics. Even the quotation above admits life " has an inner significance and an ultimate meaning," although the mechanical view would not appear to call for either. However, when authorities like Dürken assure us that the more profound our study of biological problems, the more we are led away from any mechanistic conception of the organism and therefore of life itself, the Christian may once again take heart from the knowledge that a Creator is the one solution of the problem that would invest life with both inner significance and ultimate meaning. Even as a theory, and were it nothing more, the meaning becomes richer and the significance deeper than by the alternative barren hypothesis. It seems to me that the very mind of the mechanist, the intelligence, the restless questing and intellectual adventure, his increasing control over environment, constitute the most effective reply to his doctrine. Put in another form this is only saying that we cannot, by any known processes, reduce our qualitative differences to quantitative ones. We may accurately estimate the respiratory quotient, the carbon dioxide formed in breathing, the heat evolved in muscular action for any animal, and express them in mathematical quantities, but who could express Gray's Elegy in the form of a quadratic equation?

We may now ask how life arose. We have seen how unsatisfactory is the reply attempted by some when they invoke spontaneous generation. Truth to tell, however, most biologists have abandoned this method of explanation, not so much perhaps because all attempts have failed to adduce a shred of evidence in its support, but rather that the method is much too crude. Wherever we look in nature we find the processes with which we come in contact are invariably delicate in the extreme. We may therefore allow that the mechanist may be right when he claims that more and more complicated organic molecules gradually arose and assumed the colloidal form. In this form they might conceivably be so like dead protoplasm as to be indistinguishable from it—that is to say, in suitable aggregations of molecules. The crux of the question now becomes: Did these fortuitously prepared aggregations of molecules need the touch of the Master-mind in order that they should *live* or did they just live because they had reached an appropriate complexity? For living involves a tremendous change in attitude towards the environment, and the combinations of characteristics differ from anything else we know in the physical cosmos. Briefly stated, these are: 1. A living thing moves about *of its own initiative.* Other things are pushed or pulled about in strict obedience to certain rules which we call natural law. A living creature disregards these or overcomes them with its own appropriate power. Its motive power resides and comes from within: it is as if it had a will of its own. However we argue round the point, this contradicts the otherwise universality of what we call physical manifestations, but is exactly what we should expect if we look upon it as a tiny chip from a block of mind. 2. It grows, not as a crystal does, by addition or accretion of already existing material like itself, but by taking complex bodies into itself, breaking them down, absorbing them into its own substance and building them up into many and varied tissues, all of which are now at a higher energy level than before. The whole of the rest of the universe is continually passing to lower energy levels. 3. It reproduces itself. By processes unknown to anything else it forms other living creatures like itself which have the same powers—or, in the course of evolution, increased and increasing powers. We might mention other unique features, such as respiration, but those set out are enough for our purpose.

We speak of a creative act, but it must be admitted that to most people it is a very vague sort of happening and it would probably puzzle them to write down or say what is involved precisely in such an act. What the mechanistic biologist really objects to (if I may put the problem very crudely) is the notion of taking a lump of clay, moulding it and then mysteriously transferring to it a sort of ethereal property or entity called life—it is the mystery to which he objects, and if he could be supplied with some mechanical conception of the chemical or physical or both processes, he would probably be content. Yet we have only a moment ago seen that all living organisms take in complex *dead* molecules of protein—no matter whether they have stomachs or not—break them down, absorb them, build them up again—all of which he would agree are chemical and physiological processes. But what of the next link in the chain? If we could actually follow some of these molecules to their locations, some would be found, say, in a muscle, some in a gland, some in the heart and some in the frontal part of the brain which does the thinking. The molecules are not merely *included* in these tissues, they have become an integral part of the living apparatus, as much so as the molecules that were already in the tissues, and they are now taking their due share in the working of the living machine. How has the transformation from dead to living been effected and exactly where has it occurred? The mechanistic biologist does not question the end result—he is familiar enough with the fact that this is happening momently in his own body. Yet the mystery of dead to living is not one whit less than trying to visualize a creative act. What says the poet (and scientist)? " Life takes some dust, A little rust, A crust of bread, And makes a must—Blood hot and red;—And joy, and pain, and love, and lust Rise from the dead."[1]

It was asked above, how and where the transformation occurs. The where is not so difficult, since food products are carried by lymph and blood to the various tissues of the body. Thus the transformation from dead to living must occur in the cells of the tissues after they have been taken up. As for the " how," neither biologist nor physiologist nor anyone else has any knowledge or even an idea. The only thing we can say about the marvel is that there must be contact, dead molecules must be brought into touch with living cells for the change to be effected. The notion of contact being the essential feature of creation may seem strange to some, even impossible. It is not necessary for a creative act to be demonstrative and be accompanied by a dramatic display of energy. Incidentally, we may note that Elijah found the manifestation of God lay, not in storm and fire, but in a still small voice. If there is any suggestive truth in this, it would only be falling into line with it to conceive the creation of life being as unassuming and unostentatious as mere contact. We should have to suppose there is a something transferred and conferred. We *do* know that the above procedure seems to be followed when, say, a particle of egg albumin (i.e. the white of egg) is eaten, its protein broken down into amino-acids, absorbed as such, then built up again into *different* proteins, carried to a cell in the skin or the brain, there to become a living part of the tissue. However we look at it, the last link here is that from dead material there is creation of livingness by contact—whatever else may be involved, contact is the essential. Is it not probable, then, that the first creation of life was of this nature—contact of suitable colloidal molecules with the Creator?

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[1] Ronald Campbell Macfie, *Collected Poems*, p. 173.

The reader may interpose a criticism here. It may be said that while the facts given above are not doubted (as they cannot be) I have chosen an isolated instance, that they constitute a unique phenomenon and consequently the deduction is not justified. The reply is that so far from being unique, similar instances of mere contact producing results occur in the body (both in man and animals and plants) and even quite commonly in the physical world. Examples in the first class are found among the many enzymes which promote the processes of digestion. They are not the ordinary digestive juices (pepsin, pancreatin, etc.) for they are never used up—there is as much enzyme at the end as at the beginning, and a definite amount is competent to work upon half a hundredweight of food as easily as upon half an ounce. The remarkable feature is that neither energy nor substance is used up. One example of the second class must suffice although many might be given. Most people nowadays know that water consists of two atoms of hydrogen linked up with one atom of oxygen. If we place a certain volume of oxygen in a tube together with twice this volume of hydrogen the two gases mix intimately; but even if kept for years under ordinary conditions, they do not link up and form water. They *can* be made to combine, e.g. by passing an electric spark through the mixture, when there is a violent explosion and water is left. If, however, we take our mixture of the two gases and drop into the tube a few grains of powdered platinum, the explosion occurs as before and water is formed. The platinum remains exactly as it was both in character and quantity—it has neither absorbed nor given off any energy. Contact alone, neither more nor less, has produced this astonishing energy change.

I have dwelt upon this question in order to show that mere contact is capable of working mighty changes and if we are satisfied that God exists it is not necessary to introduce a violent anthropomorphic element to account for creation. It would not violate the mechanist's demand for unbroken continuity of law and order, but God's existence and need for contact with the universe would still remain and He would not be literally thrust out of His own domain. All this is certainly not irrational; it preserves the continuity of inorganic, organic, animate—a growing advancing complexity with no breach. Not only is the oneness of the picture maintained: it imposes no barrier to the possibility of the eventual evolution of a soul when development has reached the stage where a personality may be housed, as in man. Nay more, for it establishes the family relationship between God and man—the friendship of Father to children.

CHAPTER VII

THE NERVOUS SYSTEM

So far, we have been trying to fathom the mystery of life in a more or less theoretical way —life in the abstract, so to speak. There has necessarily here and there been a direct reference to a live organism, or to an organ. We must now attempt to give more attention to the organisms themselves as we find them actively engaged in their daily business. This does not mean we are embarking on a detailed anatomical study, for such would be impossible; rather, we shall concentrate on a very brief survey of certain parts of them which will shortly have a peculiar interest for us because they are concerned with several problems we shall try to face and which call for some elucidation in relationship to our main theme. In doing so, let it be said at once that for anything like a comprehensive understanding of the world of living creatures we must whole-heartedly accept the theory of evolution. It is not implied that we necessarily retain exactly the theory as laid down by Darwin, for many biologists consider many of his views need considerable modification and he would have been the first to admit the justice of much of the later criticism. As an example, had Darwin known of Mendel's experiments and laws he could never have elaborated his theory of pangenesis as set out in Chapter XXVII of his *Variation of Animals and Plants under Domestication*, and much of his other work would have been modified in consequence. One word of caution may be useful, viz. that when we speak of Evolution we mean a process—a way in which things are done. It is not implied in the least that some mysterious "agent" is at work directing and doing. The evolutionary theory is a history of how simple beings have been modified and altered, becoming on the whole more complicated, climbing a ladder from lower to higher, ever with more grasp of and control over circumstance and surroundings, inclusively known as environment. Evolution as such has no influence on whether we believe in God or not. It merely says that it is an alternative method by which the animate world has reached what it is to-day—an alternative to supposing that all the main classes of creatures were suddenly brought into being and have remained much as they were at the first. Many wrongly assume that Darwin formulated a way to account for the origin of life which dispensed with a Supreme Being. Nothing of the sort: he never attempted to settle the method of the origin of life: but life having appeared he sought to show how vast numbers of variations occurred and improvements arose.

It has been shown in what the chief parts of a single cell consist. Gradually a number of cells- colony.

these remained in contact, forming a sort of colony in which all the cells are very much alike. As time went on some of the cells took on one kind of work, some another, and began to differ more and more in character—this being known as differentiation. It thus came about that after long ages there slowly appeared totally different structures, such as muscle and bone, brain and nerves, glands and skin, kidneys and liver, and others too. By this time specialization reached such a pitch that one kind of cell lost all capacity for work except its own special kind. Blood carries food and oxygen, taking up also certain waste materials; muscles cannot do these—their work is to provide the means of movement and so on. A brief account will be given of the structure of some of these organs in man, and we begin with the nervous system.

Division of Labor (Differentiation)

The nervous system in man (and in the higher animals) is described as consisting of three parts: 1. The Nerves. 2. The Spinal Cord. 3. The Brain. For our purpose the brain is by far the most important; the spinal cord will present a few interesting features, while the nerves need not occupy us long, as their function is a passive one.

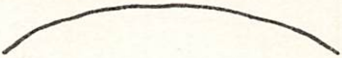
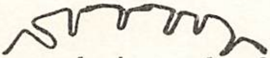
1. The nerves are the lines of communication. Every nerve ends (or begins) in nerve cells, which are usually situated in the spinal cord or the brain. A nerve of any size is really a multitude of nerve fibres, and these break up into finer fibrils. Every nerve carries a message which may be *a* going to the cord or brain (such as touch, pain, taste, hearing, etc.) when it is

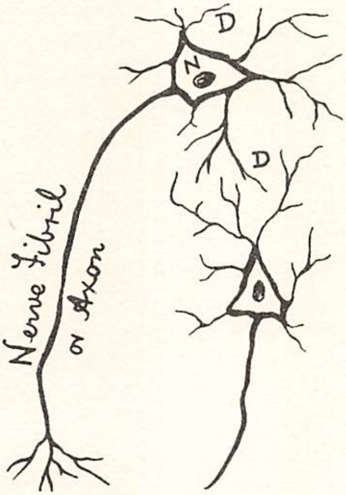
called sensory or afferent, or β coming from the cord or brain, resulting in movement by means of muscles, gland activity and the like: in this case it is called motor, or better still, efferent. These ingoing and outgoing messages have their own nerves: one nerve never carries both, but which kind of nerve it is cannot be distinguished by microscope, staining or any other method.

2. The spinal cord is a very complicated structure and, when cut across, the naked eye can easily distinguish two parts—white matter and grey matter. The white matter is really made up of bundles of nerves, each nerve going to a definite destination, to or from the brain. This white matter (the nerve bundles) is always outside, i.e. on the surface. The grey matter (lying inside) is made up of nerve cells which are carefully stowed away in a packing material, keeping them in their places and shielding them from any jars they would otherwise sustain. [A typical nerve cell will be described shortly.] If we trace a message, say from the hand, we shall get a general idea of how the simplest combination works. We touch the head of a pin: the contact is called a stimulus. In the skin is the end of a nerve fibril: the stimulus flashes a message along the fibril and along the nerve at the rate of about 100 feet per second, up the arm, into the spinal cord at the level of the neck. Here it reaches its own nerve cell. This cell is in association with another nerve fibril which runs up the spinal cord in a white column and so to a nerve cell in the brain. On the way there

may be another similar break at a cell, but either directly or indirectly the signal reaches the brain. Had we touched the pin-point, so that it was painful, a message at once flashes back, and the muscles of hand and arm, obeying the signal, remove the finger from the pin. Many similar movements are carried out by a signal being sent back immediately to the point of the stimulus, without the brain's intervention. This is called a reflex act: an act which we shall have to compare with what occurs in the brain. The ingoing nerve, the nerve cell in the cord and the outgoing nerve to the muscles together make up what is called the "reflex arc." Similarly, the sight of a lemon, the smell of an appetizing meal will cause saliva to flow into the mouth. The result here is not muscular movement; instead, a gland is thrown into activity. These reflex acts are immediate and involuntary and occur without any conscious interference on the part of the brain. The grey matter of the cord runs throughout its whole length and so provides the apparatus for reflexes in every part of the body—the lowest part for legs, the middle for abdomen and chest, the upper part for arms, head and neck. We must now say something about the brain.

3. The Brain. The brain may be looked upon as the enormously enlarged and expanded front (or, in man, the upper) end of the spinal cord. It is at once the most complicated and marvellous physical structure in the universe—as far as we can discover. As we go upwards along the spinal cord and as the spinal cord is

merging into the brain, the white outer part (really bundles of nerves) begins to dip inside and is very soon entirely lost to view. At the same time the continuation of the grey matter of the cord comes to the surface. Now the cord is, strictly speaking, a tube although the canal inside is very small. It is exactly as though this tube at the upper end had been turned bodily inside out. The result is, we see nothing but grey matter when we look at a brain. This may seem to be a remarkable thing, but there is a deep significance attached to this change. For by this inside out arrangement the amount of room which the grey matter can come to occupy is capable of being very largely increased. Since it is the grey matter that does the work this is a most important consideration. The device adopted for increasing the area of grey matter is as follows. Looking at a human brain, we actually see about a square foot—if it were laid out flat. But the surface is not smooth; it is covered with ridges and furrows. Instead of being  it is  The ridges are called convolutions, the furrows are sulci. By this means the surface area is increased to about 3¼ square feet, for the grey matter dips down into every furrow. Thus, of two brains apparently the same size, one may be definitely better than the other if the furrows are deeper in the one, for there will be a little more surface grey matter. The average thickness of grey matter is ⅖ of an inch, the weight of the brain in man is 48 ounces and there are something like 30,000,000,000 nerve cells. At birth we each have our full total of nerve cells, and if even one is destroyed it is never replaced. Most other tissues in the body can replace lost cells (as skin and bone do in healing), but not the brain—the cells are far too specialized and have lost their power of replacement. What, then, is this marvellous nerve cell like? Like any other cell it consists of protoplasm—the outer cytoplasm and the inner nucleus (N). A typical brain cell is roughly shaped something like a pyramid, from the apex and sides of which fine, branching twigs go off. These are the dendrites (D). From the base there goes off the nerve fibril, and this may be even a few feet long and ends in branches, associated with the dendrites of another nerve cell, or in a taste-bud of the tongue, or in the retina of the eye, or in a touch corpuscle of the skin, or in a muscle fibre, etc. The dendrites of the cells in the same neighbourhood can pass on a stimulus, which they



may receive, to each other, and thus thousands of them co-operate for even any trivial action that may be needed. Those which work in unison, say for movements of the hand, are said to constitute an area, and so we have areas on the brain surface for face, lips, neck, chest, arms, legs, and also for separate internal organs. As all these intercommunicate, the complexity is almost unthinkable. Beyond the mere mention of these we cannot stay to discuss them, for our main concern is with the front part of the brain —the so-called frontal lobes, right and left. These have no direct control over movements or pure sensation such as pain, hearing, sight, and so on. They are concerned, however, with all that is highest in man and distinctive of him —thought, reason, intelligence, capacity for and development of mathematical, musical, artistic and other faculties—those things which mark off Homo (i.e. man) and confer on him the epithet *Homo sapiens*, as distinct from Pithecus (i.e. the ape) and all other animate creation. Here dwells the Mind, of which we shall shortly be speaking.

Although for more detailed description physiologists divide the thickness of the grey matter into as many as eleven or more layers, we may for our purpose be content with recognizing three main divisions: 1. An outer or surface layer (supragranular). 2. A middle (granular). 3. An inner (infragranular). In what immediately follows it must be understood that we look upon the brain as a piece of mechanism for descriptive purposes and in so doing we are not committed to the mechanistic theory of the *nature* of mind, for we shall see soon that although the brain is a magnificent piece of machinery, the mind works *through* it. Not only so, the mind *needs* such a perfect machine for its action; anything less perfect would only obscure its refinements. As we shall have to consider, in the next chapter, the nature of mind and its relationship to the brain we will leave these structural considerations of the brain, and say a few words about the structure of one other class of organs which bear upon our main theme, viz. the glands.

Glands. These may broadly be divided into two groups: α Those which form their own peculiar substances for local use only; these substances, dissolved in appropriate fluid, are collected in a very fine system of tubes or canals and passed into larger ones (sometimes into one) which then pours out the secretion, as it is called, at the point where it is needed. Examples are the glands in the mouth forming saliva; the liver forming bile which is poured into the gall bladder and into the intestine; the pancreas sending pancreatic juice to the small intestine. These, however, do not concern us. β There are several other important glands which manufacture remarkable substances, but instead of being carried to one definite place by a canal or duct, the secretions are passed directly into the blood, which carries the products very quickly to every part of the body. They are called the internal secretion glands and their products are most potent. In addition, many of these secretions are vital—the complete absence of them inevitably means death. Examples of such glands are the thyroid, in front of the neck just below "Adam's apple"; the parathyroids, tiny glands behind the thyroid, no bigger than the head of a pin; the adrenals, sitting on the top of each kidney; the pituitary, consisting of two parts with totally different functions, lying under the brain; the sex glands, which, as we all know, are extremely potent. These internal secretion glands will be the subject of a more detailed discussion presently, when there will be two aspects of which we must not lose sight: 1. Their products undoubtedly exercise a marked influence on the actions of us all as individuals; 2. A fact that is frequently overlooked—the individual can, on the other hand, exercise control over his or her glandular equipment.

CHAPTER VIII

THE NERVOUS SYSTEM AT WORK—THE MIND

THUS far, in our approach to the study of mind, we have looked very briefly at the structure by means of which the mind is constrained to show itself, viz. the brain. In general, we freely admit the association of a mechanism with the operations of a mind, but this is quite a different thing from saying that the mechanism explains mind. We encountered the same problem during our inquiry about life and found that all the mechanical associations fail to touch the fringe of any explanation of what life is. There is the same danger here as we met in studying life, where biologists have talked so much about and stressed the physical basis of life, that is, protoplasm, that the physical basis is regarded by many as synonymous with life. This is most certainly not the case. So it is with mind and the brain. It is scarcely possible to overstate the mechanical marvels of the brain as a structure, and for this very reason the tendency is to dwell upon these marvels until it seems an easy assumption that the brain *is* the mind. Once again, however, mechanism is very far from being the last word. Speaking on this subject one of our foremost experts, first reverting to living organisms in general, says such a science (the mechanistic view of physiologists) is based "upon a vast assumption, the assumption, namely, that all the processes of living organisms are capable of being mechanically explained. This is a gratuitous assumption which finds no justification in facts. For no single organic function has yet been found explicable in purely mechanical terms; even such relatively simple processes as the secretion of a tear or the exudation of a drop of sweat elude all attempts at complete explanation in terms of physical and chemical science."[1] Mark the emphatic language—gratuitous assumption. Going on to discuss the brain elements and detailing a few of the wondrous processes which go on in this organ the author continues, "First, we have no warrant for the assumption that the mechanical processes of material structures, however complex, can issue in movements that have the characteristics of behaviour. Secondly, we have no warrant for believing that such processes can of themselves produce sensations or feelings of any kind, or can be in any sense identified with the processes of consciousness."[2] This general statement, however, is considered to be too incomplete, and McDougall adds, "Thus, mental evolution leads the way, and evolution of bodily structure is in the main the consequence of it; and this remains true no matter what theory of the conditions of evolution we adopt. . . . Even if natural selection of spontaneous variations has been the sole method of evolution, such selection was only rendered possible by the struggling for existence, that is, by the sustained purposive efforts of the animals to maintain their own lives and to propagate their species. . . . Thus the main stress, the brunt of the work of evolution, has been borne by the mind; the mind has been the pioneer of bodily evolution; the bodily organs and functions have been merely the instruments through which the mind has accomplished its purpose."[1]

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[1] W. McDougall, M.B., F.R.S., *Psychology*, p. 34

[2] *Loc. cit.*, p. 74.

Now all this, put into everyday language, means that the theory of mechanism does *not* explain life (a subject with which we have already dealt); that no matter how complicated we assume mechanical processes to be, these cannot result in those features which we call behaviour; nor can such processes end in what we call consciousness. To say that these mechanical happenings are responsible for behaviour, sensation, consciousness, is just "putting the cart before the horse." For, instead of bodily and mechanical structure becoming advanced and "higher" so that at last it succeeded in giving birth to mind, McDougall assures us that Mind has ever been in the van, and that, leading the way and thus being purposive, the bodily organs and functions (i.e. the machinery of the body) *have been merely the instruments* through which the mind has worked to better and loftier platforms. Thus we reach, by a different route, the conclusion at which we

[1] *Loc. cit.*, pp. 175, 176.

previously arrived, viz. that Mind is the creative factor; Mind with its purposive, directive selectivity, as sharply opposed to the concept not only of matter being the *fons et origo,* but also of mechanism as being the actual motive power.

Now if Professor McDougall were the only mental philosopher who emphatically says that mechanistic teaching is quite incompetent when dealing with this problem, the seeker after truth might hesitate to follow; but he is not by any means. It would be difficult to find a more authoritative opinion than that of Sir Charles Sherrington in all matters concerning the brain, and being a physiologist his views are all the more significant. Before proceeding it may be well to remember accurately what is a reflex act. It is an act which is performed immediately, without deliberation or reasoning and into which consciousness does not enter, in response to a stimulus. The stimulus acts on a nerve ending (it may be touch, sight, hearing, etc.) and an impulse passes to the nerve cell, usually in the spinal cord, whence another impulse at once passes back to the region of the stimulus. There are those who would reduce all thought, reason, intelligence, elaborate deliberation, to a species of reflex act—very complex, it is true, yet all behaviour is regarded as nothing but a series of very complicated reflexes. Sir Charles Sherrington says, " There are some motor acts " (i.e. acts which involve movement), " essential but hardly significant as behaviour, which are driven by nerve action generated not from outside but within the brain itself,"[1] which means that these are not reflexes, and we shall see the significance of this a little later. He goes on, "Signalling in the brain is not traceable therefore entirely to outside influence; that warns us against supposing that all signalling in the brain is reducible to the reflex principle."[2] In other words, we reach the conclusion that however involved some reflexes may appear to be, there is yet that something in the brain which is above and beyond the obvious mechanical side of it. After considering briefly a few aspects of animal behaviour the lecturer continues, "But are suites of acts the whole of an animal's behaviour? Are they in ourselves the whole? We know that with the muscular acts of our behaviour run mental events. With the signalling in the brain-nets managing our muscles runs mental action. The mental events run also when the nerve-nets are not operating muscular behaviour at all."[3] As if to emphasize still more the complete failure of any mechanistic interpretation to explain brain and mind we read, "But indeed what right have we to conjoin mental experience with physiological? No scientific right. . . . On the one side changing electrical potentials with thermal and chemical action" (i.e. in brain cells and nerves); "on the other, a suite of mental experience, an activity no doubt, but in what if any relation to energy? As for me, what little I know of the how of the one, does not, speaking personally, even begin to help me towards the how of the other. The two, for all I can do, seem to remain disparate and disconnected."[1] And again, "Where the final step deals with muscle, to say signal seems enough. But when trying to collocate nerve action with mental activity we face something which not only transmits signals, *but reads them.* Otherwise the signalling, whatever its complexity, remains just one red lamp showing itself to another."[2] Before attempting to assess the meaning of these and a few following quotations we may well ask the pertinent question—is life, to any one of us, just a series of red lamps showing themselves to others? If so, we are merely marionettes in a figure show, and we have no more significance than these puppets. As says the Persian poet:

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[1] Sir Charles Sherrington, *The Brain and Its Mechanism*, p. 8.
[2] *Loc. cit.*, p. 12.
[3] *Loc. cit.*, p. 21.

> For in and out, above, about, below,
> 'Tis nothing but a Magic Shadow-show
> Played in a Box whose Candle is the Sun,
> Round which we Phantom Figures come and go.

Nay, worse than this; for there lies in us a rooted conviction that we *have* some significance, but all the while we are merely being deluded, tricked by the most cruel deception that a spiteful, malignant Nature could invent! However, we may proceed. "The events we have to correlate with the mental events are not themselves then of the reflex type at all. . . . Mental action lies buried in the brain, and in that part most deeply recessed from the outside world, that is, farthest from input and output. . . . The futility of searching for correlation between any one or all of these nerve-actions and mind is proclaimed by the circumstance that each of them is best known in nerve-structures where certainly mind is not."[1] For the benefit of those who have not an intimate knowledge of biology it will be an advantage to translate all this into non-technical language. The latest evolutionary development in the brain comprises the frontal lobes which lie immediately above the eyes and nose. It is universally accepted that this is the thinking, the intellectual part of the brain. The relatively enormous development of this, both in size and extreme intricacy, marks man off from all the other creation. Behind this, almost midway between front and back, are the parts which have to do with ordinary sensation and the various movements to which these give rise. The mechanistic biologist tells us that the frontal lobes constitute the mind; they produce thought, reason, volition, everything which is classed as intellect, the production of these being no less mechanical than that of bile by the liver, digestive juices by the pancreas, tears by the eye gland and so for a multitude of others. One more fact may be given in association with those immediately above. At the extreme back of this upper part of the brain which we are discussing, are two bluntly pointed lobes (one on each side) called the occipital lobes. These have to do with vision. Injury or disease of one of these results in blindness of the eye on

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[1] *Loc. cit.*, pp. 22, 23.
[2] *Loc. cit.*, p. 25.

[1] *Loc. cit.*, pp. 26, 27, 28.

the opposite side. (As in all movements and sensations the one side of the brain governs the opposite side of the body.) Now it will be seen that this area is one of very great importance and is very highly developed. In the last quotations given above, Sir Charles Sherrington is saying in the plainest and most emphatic language that we know a great deal about the parts of the brain which govern the movements of the whole body and also of those which govern sight, hearing, speech, touch. These areas we can map out very accurately. Not only are they sharply marked out; the brain tissue is highly specialized and developed. These are the parts where what he calls nerve-actions go on. The location of these nerve-actions is very exact, as is abundantly proved by disease, by injury and by direct experimentation. But these very areas where there is such intense specialization and such unparalleled activity, are just the very areas where the mind does *not* reside. In other words, the mind has its own separate and distinct part of the brain. It is, of course, connected with all the sensation-movement parts of the brain (called, in technical language, sensori-motor areas) and is in constant touch with all that happens there. This mind part of the brain is not present at all in lower animals, and even in the highest, such as apes, dogs, horses, it is relatively quite small. In man it has grown in extent and importance out of all proportion to its amount in other animals, and this stage of development has been reached with amazing rapidity. If one may venture on any definiteness we may say that in something like 100,000 to 300,000 years a vastly greater step forward has been taken than in the previous (say) 200,000,000 years! All this, apparently, for somewhere to house the mind of modern man. This is not all, by any means. In saying that this sensation-movement part of the brain is very highly specialized and developed it must not be supposed that the frontal regions are less elaborated; not at all. The closest examination indeed reveals no structural differences. As Sir Charles Sherrington tells us, "There is, so far as I know, in the chemical, physical properties, or microscopical structure no hint of any *fundamental* difference between non-mental and mental regions of the brain."[1] The italicized word, by the way, is in the lecture and is not mine, suggesting a specially stressed importance. The point we would like to raise (and it may have occurred to the reader) is this: If the whole of this marvellous organ is a mechanical contrivance which has chanced to develop as it has done, and the mechanism is solely responsible for sensation and movement (nerve-actions) and also for so totally different a quality and function as mind, one would surely expect the microscopic structure to be at the very least recognizably different to correspond with two such distinct productions. It would seem to be more in keeping with a machine if sensation and movement belonged to the whole brain and somehow, intimately bound up with and among it all, mind emerged as a direct result of these. Indeed such a scheme

[1] *Loc. cit.*, p. 28.

would appear to be inevitable. Instead, we find the sharpest localization and limitation of areas and, strangest of all, a definite area is reserved for mind which is certainly *not* the sensori-motor part of the brain. On mechanical analogy alone we ought to find one kind of machine being responsible for sensations and movements and all the consequences that flow from them and another radically different type of machine for mind, that is, if mind is merely a mechanical product of the brain. The same type of investigations which tell us so much about the sensori-motor areas in the brain ought also to reveal something about the *way* in which the frontal lobe cells produce consciousness, reflection, volition independent of any reflex acts, judgment and choice, appreciation of values and many another faculty.

Now it is a remarkable reflection that (if the mechanist is right in assuming that brain "secretes" mind) in no other region of the animal body does this condition obtain. If stability and framework are sought we look to bone (or in the crustacea the hard outer shell of chitin) which proves itself very efficient; we do not expect, however, that bone will provide something so radically different as saliva. We do not expect muscles to provide movement and also a thyroid secretion. We do not find skin providing a circulatory system—that is the function of the heart and vessels. The kidneys do not move limbs. And so, throughout the whole of the body. Nay more, the glands (to which we shall come later) are all sharply distinguishable.

The thyroid is not the least bit like the pituitary, nor is the adrenal like either—a medical student can distinguish them accurately. In only this solitary case are we asked to believe that the same kind of cells in one organ can produce two such "disparate and disconnected" results (to use Sir Charles Sherrington's words) as nerve-action and mind. When we ponder these things any mechanistic interpretation seems to become more and more inadequate, and certainly biological considerations do not give these and kindred views much countenance. Whatever view we may ultimately adopt with regard to the curious question of multiple personalities the fact that in certain cases an individual may at different times exhibit two (or more) totally separate and distinct personalities bears out in a striking manner what has just been said and gives no support to a mechanistic interpretation of the higher functions of the brain. For, viewed as a pure machine, it is beyond all belief to suppose that the cerebral cells in the frontal lobes should at one time be associated with and produce a personality A and in a few moments should exhibit a radically distinct and different personality B when apparently no physical causes can be found for the dramatic and instant change. More than this, the subjects of this aberration assure observers that self A can look down, as it were, on the acts, feelings and thoughts of self B, but while actually criticizing these, self A seems powerless to influence self B.[1] It may very well be asked, What prospects have chemistry and physics of explaining such remarkable phenomena?

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[1] See Dr. Morton Prince's *The Dissociation of a Personality.*

It will be remembered that I have already referred to a British Association sectional address by Professor Myers when dealing with the physical aspects of our subject (p. 49). While the whole of his presidential address is full of suggestive methods of approach to our subject I must perforce be content with only one or two further references. His reputation as an authority on Mind is, of course, world-wide and unquestionable. After pointing out that consciousness implies self-activity (not an activity which is merely reflex and so at the beck and call of every varying whim of the outside world) he says, " There are no separate loci for different kinds or modes or qualities of consciousness. . . . It is impossible to localize consciousness. There are no specific 'mental' symptoms diagnostic of cerebral tumours in different regions of the brain."[1] Let me explain exactly what this means and the implication it carries. Take a case of a person who is suddenly seized with paralysis of the right arm and hand (usually it is not so simple and uncomplicated as this, but we are purposely limiting our inquiry to the simplest instance). The surgeon—and physician, too, for that matter—knows exactly where to look for the cause of the seizure and knows also that it is probably due to the stopping of a blood-vessel by a clot or by a blood-vessel giving way, the blood poured out pressing upon a definite "area" of the brain: the suddenness is against a tumour being the cause. This area is on the *left* side of the brain at a point a little in front of the upper part of the ear and about half-way up from here towards the middle line of the head from back to front. Similarly we can map out areas governing leg movements, speech, and so on. The point of this very rough and brief description lies here. The parts of the brain governing ordinary movements of limbs, internal organs, face, lips, tongue and so on, and the parts governing sensation, such as sight, hearing, touch, are all known with considerable accuracy, and when any of these " go wrong " they lead to symptoms which also are well known. Thus, what may be called the more mechanical parts of the brain are sharply demarcated and disease or injury causes a definite train of symptoms by which we can tell with certainty what part is affected. Moreover, these are parts of the brain which man specially has in common with animals even rather low in the scale of creation. For the sake of distinction we may speak of their symptoms as physical or bodily ones. Now what Professor Myers is saying in the above quotation is this: that while the mechanical areas are sharply marked out, not only in the brain as a whole, but also from each other, their positions not varying, there is no similar mapping out of the higher parts of the brain, so that disease of one particular point in the frontal lobes would give rise to a certain train of *mental* symptoms, while disease at another point would give rise to another totally distinct train of mental symptoms.

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[1] Sectional Presidential Address, British Association, 1931, p. 13.

It is well known that in evolutionary development the highest faculties are the last to appear. As these do so the lower ones become (as it were) more buried and therefore more automatic. We do not (in health at least) consciously breathe or control the heart-beat, but we do reason, approve or disapprove behaviour, praise or not a beautiful picture or landscape. In the taking of an anæsthetic the person first loses finer judgment and all the higher faculties are lost in the reverse order of their evolutionary acquirement. Consciousness and the " mental faculties " are especially associated with the frontal part of the brain, but not altogether, for they are to some extent diffused over the whole of the cerebral hemispheres. In other words, the really mental faculties need the outer layer (i.e. the supragranular layer) for their manifestation. Yet, delicate and important though they be, and in sharpest contrast with sensation, movement, etc., there is no apparent localization whatever of the separate intellectual faculties. If the brain were solely a mechanism and the whole of evolutionary progress were a mechanical one, only a blind fortuity and no purpose behind it, surely it is more than passing strange that the method hitherto adopted so consistently should suddenly be abandoned when it comes to providing an equipment which can truly be called mental and conscious. For up to this point in the development and expansion of the brain and its functions, the one insistent method pursued had been localization, localization, and still more localization. It is almost as though nature regarded this as the one golden way of avoiding any confusion of functions, and yet, when it comes to a vastly more intricate issue and problem, that of intellectuality as distinct from mere automatism, the tried method was discarded and localization suddenly became a dead letter. What if the experiment had proved to be a failure? The crown of evolution would have been wrecked and man, as man, would have been intellectually as barren as the Dead Sea. This is the point to which pure mechanistic teaching leads us. Only by recognizing a guiding purpose can we escape such a dilemma, and no wonder the whole of Professor Myers' address is directed to showing that Mind is something that cannot be accounted for by mechanism alone. Mind cannot be caged within the limits of a mechanical contrivance; its freedom alone is testimony enough against that. It is not a question of assembling a number of spare parts, making them efficient as may best be; instead, there definitely appears to be the object of welding whatever is needed into a marvellously harmonious whole. What we know already of pure mechanism does not appear to be the best means of achieving this result.

It may seem that so much emphasis has been laid on the inadequacy of mechanism alone to account for organisms that it has but little part to play. This would be a distorted view in the opposite direction, for mechanism has its own definite place and its functions are important. The mistake arises when we try to push it beyond its legitimate sphere: it is then that the key no longer fits the lock. Yet the scheme of the universe being what it is, whatever the reality underlying all activity may be, it obviously needs some mechanism for its exhibition to our senses. And here a remark may be made about these senses—the avenues from the outside world which bring information and impressions for interpretation by the mind. The limitations of the senses are obvious enough, but the inference from these limitations seems to have been completely overlooked. An example will show what is meant. Consider the amazing variety of rich beauty revealed by the eye—friends and flowers; the ever-changing panorama in sea, sky, and earth due to seasonal changes and hundreds of other things, all due to the influence of light on the retina of the eye. Yet little more than forty years ago we had no knowledge of the vastly greater range of vibrations on either side of those we call light—the infra-red and the ultra-violet. Included in these latter are the X-rays and the γ-rays. By no acuteness of vision could X-rays, for instance, have been discovered, much less the γ-rays; but they were none the less really there. So for many other phenomena which neither eye nor ear, touch nor taste could ever, unaided, discover There may be thousands or millions of strange happenings in this universe which our senses, marvellous though they be, never will reveal and never can. How can we say, then, what undiscovered modes of action may be at work? In view of almost infinite possibilities (for anything we know) in such directions it seems to me extremely presumptive to insist on a mechanistic interpretation and count it an "explanation." Especially is this so when this and earlier chapters have shown upon what feet of clay the whole doctrine stands and how the most eminent authorities look askance at it. We cannot be surprised if a scientist and a poet was moved to say:

> Like tides on a crescent sea-beach,
>   When the moon is new and thin,
> Into our hearts high yearnings
>   Come welling and surging in—
> Come from the mystic ocean
>   Whose rim no foot has trod—
> Some of us call it Longing,
>   And others call it God.

As we shall be in a better position to see later, we nevertheless realize that this poet not only sensed the truth, as poets do, but knew the great creative God-mind—the one element in the whole cosmos which confers reasonableness on a world which otherwise too often seems irrational.

Among many other points and arguments introduced by Professor Myers in the address upon which we have drawn, I can notice but one more. This, as in the other cases, refers directly to the problem of mechanism. It is well known that a man (or any animal) can be supplied with a weighed quantity of food—it may consist of all the three great classes, proteins, carbohydrates and fats—which can all be estimated in calories, that is, in equivalent heat units. We know exactly, therefore, what amount of energy, in the shape of heat units, has been supplied, just as we know the number of therms we use in any gas apparatus. Under suitably controlled conditions it can be accurately calculated how much energy the subject of experiment gives off in the form of direct heat (such, for example, as by the breath and skin), muscular work, moving about, and so on. The energy so calculated corresponds accurately with the energy supplied in the food. In other words, the outgo equals the intake, or expenditure is the same as the income. The experiment has been varied over a wide range and repeated many times, always with the same result. The mechanist triumphantly affirms that we could scarcely wish for more convincing proof that the animal body (including man) is merely an elaborate machine, following the same physical rules and demanding the same requirements as a loom, a motor-boat or a railway engine. On the whole, quite true, but at the point where mind makes contact with body a very curious fact emerges. For we can apportion the energy used by various tissues. (It has been explained that food, when taken into the body, is first broken down into simpler chemical bodies—this is called catabolism—then built up into more complex ones again—this is called anabolism—while the two processes, considered together as a whole, are called metabolism.) Now it is found among the people who devote their whole time to mental occupations, professors, students, clergymen, doctors, authors, etc., that the "mental work appears to make far greater demands on metabolism than it should *according to purely physical considerations of the expenditure of mechanical energy*."[1] This is a very remarkable finding, and if the brain were solely a productive machine it ought by all physical canons to do as other physical machines do, work according to an ascertainable and even predictable schedule. But here we find again a certain disregard of things physical and mechanical and it is as if mind would tell us as plainly as possible that it refuses to be fettered by the bonds that mere mechanics would impose. It will be remembered we met with a similar warning with respect to life, even in lowly organisms, where it is impossible to predict what any excitation will elicit, for the same stimulus under identical conditions, as far as we can judge, will at the two differing times produce a different result. We may talk round the subject of life as we please, but we have to admit the staring fact that life's manifestations are unpredictable and still more so are those of mind.

The actual quotations given in this chapter may fittingly be crowned by the final words in Dr. Myers' address: "Let us always remember that blind mechanism in the material world is a truth not more fundamental than the reign of guidance, creation and purpose in the world of life and mind, and, it may well be, throughout the Universe." These words, we reflect, with all before, are not lightly spoken; they bear the marks of the highest culture, deliberate and acute judgment, and considered, mature purpose. Precisely the same may be said of the two others upon whom I have so largely drawn in this chapter. It would be possible to multiply authorities endorsing the conclusions of these three (all of whom are medical men—two of them psychologists, one a physiologist), but it was considered more conclusive to call a few to the witness-box and examine their evidence exhaustively rather than to summon scores contributing a solitary quotation. We thus can be sure that there is no suspicion of tearing an assertion from its context and distorting its meaning, for in each case it will be appreciated that the opinions chosen form the main theme of these experts in the lectures cited.

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[1] *Loc. cit.*, p. 15. See throughout the whole of *A Study in Nutrition*, by Cathcart and Murray, published by H.M. Stationery Office, No. 151.

What, then, have we learnt in our inquiry into the nature of the mind of man? The great, outstanding truth is that Mind is seen to be something very much bigger and nobler than a sort of secretion product of a bodily organ; it bears no analogy to a fabric woven by a loom or to shells turned out by a munition factory. Its consciousness, its freedom of choice, its capacity for selectivity of action, its power to " read the signals "—all these and others mark it off from some product of a bit of machinery. It is as different from the brain (which acts as its vehicle) as is life (in its essence) from the chemical and physical bodies which display it. Instead of being merely a something which has become more specialized, and a more definite unit in a large body politic, mind confers on each human possessor an individuality that is unique. More than this, in its earlier evolutionary rise and progress it has taken the reins and has acted throughout as the director-general—the very antithesis of a blind, mechanistic product. Indeed, when trying to correlate any type of physical activity in the brain with such mysteries as the translation of this activity into thought, reason, volition, appreciation of beauty, even Sir Charles Sherrington confesses he is completely baffled; for, in spite of all, " the two seem to remain disparate and disconnected " and he frankly scouts any mechanistic solution. We recall, too, that we are familiar with areas in the brain which have to do with automatism and with carrying out the voluntary behests. Yet these are just the areas where the voluntary commands certainly do *not* originate. On the other hand, volition, reason, judgment, everything that can be called conceptual, resides in a portion of the brain removed from what is associated with reflexes and thus proclaims itself to be of an order differing from the mechanical.

This is a very different interpretation from that given by Sir Arthur Keith when he says, " Medical men " (as though *every* medical man were necessarily agreed with him) " can find no grounds for believing that the brain is a dual organ—a compound of substance and spirit. Every fact known to them compels the inference that mind, spirit, soul are the manifestations of a living brain, just as flame is the manifest spirit of a burning candle. At the moment of extinction both flame and spirit cease to have a separate or individual existence."[1] Yet this very conclusion is precisely what many medical men can *not* find, but on the contrary many of the most eminent of them have been at no small pains to point out why they cannot subscribe to the mechanistic hypothesis (called by Dr. Myers a "pure assumption") upheld by Sir Arthur Keith. If we accept Sir Charles Sherrington's view of the futility of searching for correlation between nerve actions and mind, we are compelled to believe that the mechanical explanation of the mind's nature is much too facile an interpretation, and in point of fact this view neither leads us anywhere, nor does it tell us anything.

[1] *Darwinism and What It Implies*, p. 4.

CHAPTER IX

PERSONALITY

It would be impossible, in the course of an investigation such as this, to leave the subject of mind where it stands in the last chapter, for it logically leads us to ask if this mind is the last link in the mighty chain thus far forged in the evolutionary process. If it be merely an unequivocal distinctive feature that is sought, a feature that distinguishes man from his nearest animal relatives, to say nothing of more distant ones, then mind (as found in human beings) provides us with an unmistakable hall-mark. This is not to say that there is no trace or glimmering of it in other animate creation, but the gap is so wide that for all practical purposes it has become impassable. We cannot, for instance, imagine the apes reaching to the status of man. It is probable, even if the ape could now put its foot on the right rung of the ladder, that the species would become extinct long before any appreciable ascent could be achieved, which would mean a still further accentuation of the hiatus.

Considered as the result of a blind, fortuitous process, it might be supposed that mind is an undeniably satisfactory goal, and effort might well rest on its oars. This, however, is not what we find, for a very little consideration will compel us to recognize the further development of personality. Doubtless many people in their ordinary conversation do not draw any distinction between mind and personality, and use the two words interchangeably. Not only are the two different and not to be confused, they are *biologically* distinct. The truth of this is clearly seen when we examine carefully what happened at the birth of each one of us.

When a human being is to be born, the moment of conception (when this new individual is begun and will be launched on the voyage of life) is when the male sperm fuses with the female ovum. Each cell loses its hitherto indivisible identity and the two become one new creation. The development of a new animal body has begun. To this new individual each parent has contributed an equal quantity of chromosomal material. The number of these rods contributed by each parent is the same, and as far as we can tell the *quantity* of material is the same. Certain it is that the constituent parts of each rod from the male sperm tally with those of the ovum, for they join up in pairs and this pairing is exact. Thus if we number the chromosomes 1, 2, 3, 4, 10, 15, and so on, chromosome 2 in the male links up with chromosome 2 in the female and not with chromosome 14. Now chromosomes are built up of a number of bead-like bodies (called genes) and these are supposed to carry the various bodily characteristics of the parents. For various reasons which cannot be discussed now, some of these features cannot show in the offspring. Thus, if the mother is pure blue-eyed and the father is pure brown-eyed, only one of these can prevail in the infant. This is said to be the dominant factor, while the one which is there but does not show is called recessive. There is no " mixing " of any one character, but the child shows those of one or the other and may have a large predominance of those belonging to either parent and therefore be more " like " the one or the other. So far I have been referring to bodily characteristics mainly, such as tallness, size of bones, complexion, shape of features, etc. To some extent these facts show us the physical basis upon which is built the justice of the remark that a child resembles its parents.

The resemblance, however, does not begin and end here. While the various organs have been developing their similarity to those of the parents, the brain has been pursuing the same course in broad outline. Since this is the vehicle through which the mind exhibits itself we cannot be surprised if the general character of the child's mind resembles that of a parent or both of them. For the most part, intelligent parents have intelligent children; the same is true of those whose mental equipment is below the average. It is true that occasionally a genius may arise in a family which has not hitherto shown exceptional ability; so, too, a child below the average in mental capacity may fall to parents from whom it would not be

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expected, but there is a reason for this (or even more than one reason) in the *way* the genes (or beads) of the two chromosomes in a pair join up. The explanation would take us too far and would probably be too technical and I must be content with saying the above is substantially true, that on the whole the mind is a heritable quality in much the same way as the body. Thus it comes about that we speak of family likenesses—in some cases these may be very striking and in some the likeness may be more suggestive of the grandparents. The same is true in a racial sense, both as regards the bodily structure and appearance and also the mentality. We may say, then, that parents bequeath quite definite characteristics to their offspring. In this heritage there are quantitative and qualitative elements, and it will be evident that up to a point, in so far as the real resemblance holds good, the activities, bodily and mental, are imposed upon the children. In this sense, therefore, there is a distinct limitation of action which means a certain amount of curtailment of freedom.

But what of the personality? Take a family, say, of half a dozen children: they are similar enough in appearance; the mental capacity as a rule is pretty much the same. Yet in spite of a similar inheritance and an upbringing in identical surroundings during the most plastic and impressionable years of life, can we say that the personality of one child is in any sense or degree the same as that of any of the others? Emphatically, no. It is a matter of common observation that, despite the bodily characteristics being similar, and the mental equipment being pretty much the same, none of the children are alike in personality. More striking still is the fact that every child differs in its personality from its parents. So marked may this frequently be that it is a not uncommon remark that parents do not know where this characteristic or trait comes from in A, B or C. They are puzzled, for the likenesses of form and mind are clearly there. Yet if variability and actual variation be a fact in biology, it is surely seen here. Nor have we any hint where to look for the cause of such variability—it just seems to set at naught everything else we know about Mendelian inheritance. As for the existence of personality lending any support to a mechanistic interpretation, it seems to be destructive of the very groundwork of such a philosophy. If we regard personality as the conscious individuality we each possess, it would appear to be impossible to account for it upon any mechanical basis. It is much too elusive in its making for that. It is, in fact, a new creation and, as such, must take its place among the other great creative manifestations. For, if there be one thing we may safely say of personality it is this—it is more unique, both in its origin and in its manifestation, than anything else we know. Viewed in this light and in comparison with all the other great moves in the world's history, it is at least entitled to this claim of a new creation. Not only is personality a new creation, it is itself in the highest degree creative.

Let us be as sure as present knowledge can make us on this question of personality. We have just seen that in living cells there is the nucleus or kernel. The essential part of the nucleus is the coiled-up thread, which, when resolved into its components, turns out to be a number of distinct rods (chromosomes), and that these rods prove to be really made up of a number of beads—somewhat of the appearance of a string of pearls. One rod may contain hundreds of these beads or genes, and a bead or small group of beads may represent a character or an associated group of them. In the fruit fly (*Drosophila*) this association has been very fully worked out and beads have been mapped out and numbered. Thus one is known to produce red eyes, white eyes or normal ones; another is associated with ordinary wings or small ones—even vestigial; another with shape or colouring of body and so on. Now these associations are definite and invariable; not only so, these factors can be controlled and even mixed artificially, and if certain factors are in certain association, the appropriate characteristics *must* appear in the developed fly. All this is very interesting and instructive from the mechanical point of view, but when we inquire what bearing these facts have upon personality, the reply is that no such things as factors for it have ever been found, and seeing that greatly differing personalities appear in one family, the quest for their factors would seem to be a hopeless one. Thus, what has been said before holds good—that up to a certain point mechanism has a hand in the game as it were, but pushed to ultimate conclusions and as an explanation it completely fails. The deeper aspects alike of life, mind and personality make the mechanical aspects look superficial and unequal to the task of real explanation.

When we come to think of these things, one of the first generalizations to occur is that we are here indubitably in the presence of freedom. In ordinary ways of thinking and of speaking, the last thing we should do would be to associate the notion of freedom with a mechanical contrivance; it just "does as it is told," so to speak. On the other hand, probably one of the first things a personality resents is doing as it is told to do, even if it is only to prove it *is* a definite individuality and is unique, and is in this respect capable of thinking for itself and also acting on its own initiative. This is quite distinct from saying we each one have that certain inner knowledge and conviction that we *have* free choice and, moreover, clinch the proof of it daily or even hourly by acting upon this assumption. Our own consciousness (which is subjective) tells us without any arguing that a mechanistic philosophy is not capable of explaining our own personality, and since we see a like attitude actuating other individuals about us, we conclude they, too, are personalities. Thus our subjective knowledge becomes objective by concluding there are other personalities —all differing and so unique. We therefore reach the same result as before, that similar bodies with similar minds do not produce (as they should mechanically do) the same or similar personalities. We may go further and say that the more completely a personality is developed, that is to say, the more individual it becomes, the more completely and perfectly does that personality attain to self-realization. Consequently, considering what has gone before, such a personality grows more and more creative, for it is approximating more and more to the Personality that is the source of all. Moreover, just as we saw that contact is the all-important condition for livingness to appear, so, in this continual enlargement of our personalities, the capacity for more intimate contact with the Maker grows ever stronger and wider. This capacity reaches its highest level in the mystics, who all bear the same witness—viz. that this actual contact with some higher, more majestic Being is in truth a reality. There are those who sneer at such experiences and would even rate them at the same value as alcoholic delusions,[1] which would mean that the personality of the mystic belongs to the same order as that of a chronic alcoholic, which, by all medical canons, is admittedly and incontrovertibly degenerate and perverted.

If we are right in maintaining that personality is the last of the great evolutionary acquisitions, it is no less true that it is the loftiest, the noblest of all. It is the most profound distinction between apes and men, and above all else gives man the right to the claim of true wisdom.

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[1] Bertrand Russell, *Religion and Science*, p. 188. Scientifically "we can make no distinction between the man who eats little and sees heaven and the man who drinks much and sees snakes."

Had it possessed no value, even the mechanistic philosophy tells us it would long ago have been eliminated, instead of persisting and growing to more sublime dimensions. This elimination, moreover, would have been all the easier because (as is well known) the last acquired characters and faculties are the most readily displaced; their stability increases with length of tenure. Being what it is, however, it is the one possession of man that has all the qualifications for establishing and maintaining contact with a personal God. In such an environment its increasing perfection is ensured, and where perfection is attained there can be no death; the inroads of disease cannot touch it; only unbroken life awaits it as its crown.

CHAPTER X

GLANDS

MENTION has already been made of the structures we are about to examine, i.e. the glands. It would be impossible even to attempt an exhaustive survey of their characters and effects. As far as these effects are concerned it may be said at once that they are among the most important and profound that are exercised in the whole animal body. If we allow that the brain (looked upon in its mechanical capacity) is the master organ or tissue, we must certainly give the glands place among the highest generals in command. Their orders, for the most part, are to be obeyed: in some cases, failure to carry out these orders means certain death of the organism. In any event there is usually the gravest interference with the economy of the animal, and this results in more or less serious disease. A like result follows if these glands (the generals in our analogy) issue faulty commands or fail to function when they are really needed.

Now glands may broadly be divided into two groups: (*a*) those which form their products (secretions, they are called) on the spot where they are to be immediately used. We have examples of these in salivary glands which pour out saliva as soon as food is placed in the mouth, or even at the sight or smell of an appetizing morsel, another in gastric juice in the stomach, pancreatic juice in the intestine and so on. Such glands may not be in actual contact with the food, but they are virtually so because the secretion is gathered by a multitude of channels which lead it to the point where it is needed. Beyond the mention of them, these will not detain us, and we pass to the second group: (*b*) These glands have no channels or ducts for carrying their products anywhere in particular. The substances they form are just passed into the blood and are carried by the blood stream to every part of the body, where they exert their effects on one or more tissues of the animal. The substances formed and thus carried to distant parts may be looked upon as messengers (and in fact are called hormones, that is " stimulators ")—messengers which have always some vital command to deliver. These ductless (or internal secretion) glands are those in which we are now actively interested.

It must be remembered that these glands are composed of multitudes of cells, just as the other body tissues are, and it is within the cells that the substances which go to make up the internal secretions are formed. Considering the object we have in view in the present discussion, the following may be regarded as the chief glands which have a bearing on our subject; and in order that our knowledge may be as accurate as popular language will allow, a few words may usefully be said about each. These glands are: The thyroid, the adrenal (called also the supra-renal), the pituitary, the sex glands (ovary in the female, testicle in the male). There are, of course, very many interesting features about these internal glands, but they are outside the scope of our particular inquiry. It may also be mentioned in passing that some glands provide both an external and an internal secretion; a good example being the pancreas (popularly known as the " sweetbread ") which pours a digestive ferment into the intestine, but also forms, by means of different cells tucked away among the others, the substance insulin, now so widely used to control diabetes. Insulin is not passed into the duct which leads to the intestine, but is taken up straight into the blood stream where it is used. And now a few words about the above glands.

The Thyroid. This gland must be more or less familiar to most readers as it lies under the skin of the front of the neck just below " Adam's Apple." Enlargement of it is not uncommon—sometimes it is very large. In general, such people suffer from a greatly increased amount of the thyroid secretion, they have what is popularly and shortly called goitre. The behaviour of these sufferers tells us pretty clearly what is the function of the thyroid secretion, for all the work it has to do normally is at " top pressure." Sufferers are unusually excitable, being upset by the most trivial circumstances; they are nervous and highly strung, often lean and active-looking. If the arm is outstretched, and the fingers spread out and separated, there is a constant fine trembling of them as though they "can't keep still." The heart beats more rapidly than usual, often, much more rapidly. The eye-balls protrude and in some cases it almost looks as though they must fall out of their sockets. This adds rather to the general picture of a "bundle of energy." Now this is exactly what the thyroid does—it is the great energizer of the body, and so powerful is its secretion that it even affects and at least partly controls some of the other glands. Thus many of the organs of the body are working very nearly up to their limit—like a factory with a "rush" of orders where the hands are feverishly working overtime because no extra help can be got. This is in the diseased condition, but normally the thyroid is just the ordinary energizer and has to do largely with normal growth. Tadpoles, fed on too little thyroid, grow to an enormous size as tadpoles, while with a relatively generous supply they change into the frog stage earlier—that is to say, thyroid secretion hastens metamorphosis. It so happens there is a disease in which the above picture is exactly reversed (known technically as myxœdema). Persons suffering from it are slow, lethargic (bodily and mentally), heavy in build, cold, dry-skinned, and all body processes go on at a greatly diminished rate. The disease occurs among the children of some districts in an exaggerated form — children who are stunted of stature, mentally defective and so on. These children are called cretins. Both these diseases, myxœdema and cretinism, can be completely cured by giving an extract of thyroid gland: indeed, the effect is almost miraculous, certainly spectacular. I shall revert to this later, meantime we continue what has to be said about other glands. It may be remarked that the thyroid has been described more fully than the others will be because it has been taken as a type.

The Pituitary. This gland lies underneath the brain, on the base of the skull. It is fixed to the base of the brain by a stalk. It consists really of two parts, an anterior and posterior, and the whole of it is roughly about the size of a cherry-stone. These two parts differ fundamentally in the effects which their secretions produce. While they do not cause the sex of an individual it is yet the fact that the anterior part brings out and develops the male characteristics, such as size in general, length of bones, manly habits and behaviour. On the other hand the posterior part contributes the more feminine features, such as the gentler and more tender emotions. Thus, tall people, especially if tending towards giant size, have either a larger or more active pituitary gland (Goliath was probably an example), while the generally smaller bones and build are associated with a larger or more active posterior part.

The Adrenal. This is a gland which sits upon the upper end of the kidney (one on each), rather suggesting a helmet. It is roughly about the size of a brazil nut. It is particularly powerful in its action, and a slight increase in its activity produces very marked reactions. It is essentially a constrictor of blood-vessels of the skin and some other parts—i.e. it narrows the blood-vessels very greatly and is thus responsible for the extreme paleness during certain emotions. It is closely associated with fright, fear, rage, and even "righteous indignation." It calls out the fighting capacities and is the gland which causes a dog's hair to bristle when he meets another that he distrusts. Deficiency of its secretion produces a profound weakness that is known as asthenia (a word seen in neurasthenia), and disease of both adrenals always leads to a fatal result. The mechanism in sudden fear or rage is that a larger amount of secretion is poured out into the blood, with the almost instant effects noted above. It illustrates very well how quickly these internal secretions act upon the body.

The Sex Glands. These glands, known also as the gonads, are associated with the characteristics of and the differences between the two sexes. All other glands are the same in the two sexes; their only variation is confined to size and hence to the amount of secretion they are able to produce. The *structure* of other glands is the same in the two sexes. In this case, however, the structure in the two sexes is radically different, so different that anyone who had never seen a microscopic slide before would immediately see the complete dissimilarity of the two. Incidentally, students may be reminded that we have found examples of structures which, though apparently alike, yet perform diverse functions. Here we are confronted with the reverse problem, viz., that structurally different glands produce the same general results, as will be pointed out shortly. If we are dealing with pure mechanism it is strange that the schemes should be the exact opposite—one would expect a like architecture. This, however, in passing.

The glands to which we have been referring are the ovary and the testis respectively. The primary, but not the only function, of the ovary is to provide ova or eggs; in the same respect, that of the testis (or testicle) is to provide sperms (or spermatozoa). An ovum is a single cell, rounded and of typical appearance. In the human species there is an average amount of the outer part (cytoplasm) and the inner kernel or nucleus, which nucleus in man contains 48 chromosomes. It is about $\frac{1}{120}$ of an inch in diameter. Although it is carried from the ovary to the womb, or uterus, the ovum has no active movement of its own, such translocation as occurs is entirely passive. The sperm, too, is a single cell but of totally different structure. It is very much smaller, only $\frac{1}{500}$ of an inch long, consisting of a head (much the largest part, yet only $\frac{1}{1500}$ of an inch across), a centre-piece and a long tail by means of which it swims actively in its fluid. There is scarcely a trace of cytoplasm, the head being almost entirely nucleus. The union of the sperm's head and the nucleus of an ovum marks the beginning of a new human life. By a most remarkable and ingenious device, just before these two cells unite to create a new being, each reduces its number of chromosomes to half, that is, to 24, so that when they *do* fuse the resulting single cell begins its great adventure with its proper number of 48.

Beyond the mere fact of the necessity for reproduction of individuals (in order that by this device the species may be maintained), the sex glands are almost entirely responsible for that driving force we call the sex urge—the urge that can produce a veritable earthly Elysium or the abysmal misery and horror of a Miltonic hell. This introduces us to the question I am about to propound and furnishes also the reason for devoting several pages to a careful, if still very brief consideration, of the subject of glands in general. For, by giving some notion of what the more important glands do in a physical capacity, we can all the better judge the reasonableness of such replies as I suggest to the questions we now ask, and the critic at least cannot say that any bias has been deliberately introduced. What we want (yes, and need, too) is a dispassionate weighing of modern problems and a conclusion that shall be both honest and reasonable.

The question is: Are our characters determined by our physical make-up, especially so by our glandular equipment? It will be realized at once what this question involves. There is also the inevitable rider to it: How far, if at all, does our glandular equipment contribute to criminality and criminal tendency, and to insanity? If we were compelled to give our reply to the first question in a monosyllable—yes or no—there could be no further discussion; for, if yes, then we are nothing but automatons, pitiable ones at that, swayed by the uncontrolled and uncontrollable outpouring of a chemical secretion, buffeted by the capricious and merciless waves of chance. It may be said that every instinct rebels against such a generalized reply, but, it may be urged, the reply is largely emotional and that we are merely piqued at the suggestion that we have no wills of our own. However, we need not rely on any instinctive revolt against our supposed manliness, for we shall find enough to answer our first query. *Do* our glands dominate us? *Do* they control the whole situation?

Take the thyroid first. It is the great energizer, it increases the rate of exchange going on continually between the food and the tissues—put in another way, between the fuel supplied and the result achieved by various organs: in this sense it is a vital organ, but there is nothing in this to interfere with the Christian way of living. It causes a fine tremor of muscle, which again cannot be a charge against moral uprightness. The worst that can be said about the thyroid in this relationship is that overaction tends to produce emotional disturbance. Here, however, we enter the province of disease. It is true that a normal thyroid may help to sway the emotions if it is showing increased activity, but if kept within limits and under control (as it can be and usually is), emotion may be a powerful factor for good in matters other than those directly concerned with Christianity. As for the general consideration of disease in glands, I am not aware that their effects are any more the concern of Christianity than are those of other bodily organs. Something will be said later about the deficiency of thyroid when it goes so far as to cause cretinism in children.

The adrenals in their normal action come under much the same category as the pituitary, but as they are also largely concerned with the fighting instinct, with anger and rage, it may be urged that they act prejudicially on Christian character, principle and virtue. Beyond saying that one reply to this consists in the fact that they are largely under control, the discussion of this aspect will be relegated to the more comprehensive one immediately following under "sex glands." Before embarking on this, it may be better to point out that these glands do not act in an isolated manner, for there is the most intimate interplay among them. It would be a gross mistake to suppose that, for instance, under strong excitation of one of them that the particular gland more especially involved has it "all its own way." In virtually all cases there is a response at once on the part of some other gland, and indeed several may do so. Thus the disentangling of results and effects may be a very complex matter. This is especially true of the sex glands which have more or less effect upon most of the other important ones. Moreover, legitimate use may easily merge into illegitimate—the border line may be very narrow. One other general observation may be made: the effect of a gland by no means ends in other glands. The involvement of the nervous system may be wide and deep, a circumstance which is not surprising when we remember that, for instance, part of the adrenal gland is closely related to the sympathetic nervous mechanism. In fact, the chief work of the adrenals in a normal way consists in maintaining the " tone " of blood-vessels through the medium of the sympathetic nerves. This might be expected when we know that the most active part of the gland is actually derived from the sympathetic system in the course of its development. Now it must not be assumed that the foregoing is in the nature of an apologia; we are not attempting any " excuse " so far, either for the glands or the man. What, then, is the truth?

It is admitted on all hands without cavil that the sex glands, in being responsible for the sex urge, are not only the most powerful of all, but they also have the greatest capacity for influencing and shaping behaviour. To say this is not to admit that the sex urge is always the master of the situation; it is powerful—yes, but not all-powerful. In as few words as possible we may trace the history of this remarkable instinct. The lowest forms of life (plant and animal) do not reproduce themselves sexually—one individual simply divides into two and the problem of continuing the race is solved. The first real indication of a move towards this development is that in lowly living forms two cells, apparently identical, will occasionally fuse or merge into one: division then proceeds again for many generations. It appears to be just an occasional rejuvenescence. Soon the conjugating cells become more and more specialized until in the higher plants the cells, male and female, become almost as radically different as among relatively highly organized animals. Now in plants we cannot by any stretch of imagination assume there is any emotional state or feeling associated with the production and union (or fusion) of the male and female cells. It is also true the same applies to animals even high in the scale. Granting the great difficulty of assessing what feelings enter into sexual acts among higher animals, it may at least be said they do not amount to a great deal. One consideration stands out; it is only in the human species that we find any approach to those exquisitely fine qualities, grouped as true love, associated with the sex instinct. This is emphasized by the fact that rarely in the animal world do we encounter any real paternal interest in offspring. If we allowed, for the moment, that sex means nothing but a mechanical device for saving the species from extinction, and seeing that the device has worked well up to the point of humanity, what need is there for any introduction of these finer emotions? Such introduction, especially the first tentative attempts, and in such crude form as they must have been, would advantage no creature. What survival value could they have? They would indeed be nothing but a cutting satire on any such notion as helping in the struggle for existence. It is far easier to understand they would actually be a handicap in a world that knew nothing of tenderness and mercy. If there could be no significance attached to a relatively sudden appearance of beauty and even sanctity in sex associations, it thus appears to be a perfectly pointless and gratuitous move in a process that up to then, and otherwise, is held by some to be just a mechanical grinding out of a meaningless automatic system. On the other hand, if there *is* a purposive direction in this (as in several other definite instances we have already encountered), a logical sequence becomes apparent and it is not necessary to *assume* an alogical core in the cosmos—an assumption that alternatively is there.

So we come to the heart of the inquiry, whether the sex urge (said by some to be really overmastering) can or cannot be controlled, be made subservient instead of being allowed to be master. In the first place there are thousands upon thousands who can and do testify to the ability to command the situation completely, even when glandular activity is at its very highest possible limit. To admit the existence of anything in the nature of free will and at the same time to allow an instinct or an urge to dominate reason and self-control is a mere travesty of the gift of choice and a biting commentary on our boasted possession of it. For if it be true that these glands hold humans in thrall and not the human who holds the glands in check, then we are in a worse quandary than "between the devil and the deep sea"; we are bound hand and foot by a merciless devil who is exultingly submerging us bit by bit in the sea to our certain eventual destruction. It need only be asked if this is a real picture of our fellow men as we see them to-day? Of some it may painfully be conceded there is more than a measure of truth in the picture, but what of the vast army of men and women living now, and who have lived in the past, who spend their whole lives, not in this flabby existence, but in a soulful, altruistic endeavour? Besides, if our glands held the reins, if they determined (by a sort of reflex action) exactly what both character and behaviour would be, there could be no rational legal system and the ordinary amenities of social life and organization could not obtain. Responsibility is a word that could not exist, for every prisoner at the bar would only need to say that this or another gland urged him and he had no choice, whereupon no judge or jury would enter a conviction. No matter what the mechanistic biologist may say about behaviour being nothing but an intricate complex of reflexes, conditioned and unconditioned, he would reduce society and the world to a sorry mess if he acted logically upon his so-called convictions and beliefs. Even a dog has to learn which instincts and glandular commands may govern and which may not. Thus the whole question hinges upon the control of this or that glandular urge. We may well listen to the advice given by one of the greatest physicians when writing about venereal disease, the late Sir William Osler: " Personal purity is the prophylaxis which we, as physicians, are especially bound to advocate. Continence may be a hard condition (to some harder than to others), but it can be borne, and it is our duty to urge this lesson upon young and old who seek our advice in matters sexual. Certainly it is better, as St. Paul says, to marry than to burn (1 Cor. vii. 9), but if the former is not feasible there are other altars than those of Venus upon which a young man may light fires. He may practise at least two of the five means by which, as the physician Rondibilis counselled Panurge, carnal concupiscence may be cooled and quelled—hard work of body and hard work of mind. Idleness is the mother of lechery; and a young man will find that absorption in any pursuit will do much to cool passions which, though natural and proper, cannot, in the exigencies of our civilization, always obtain natural and proper gratification."[1] There can be no two opinions about the wisdom of these words of gold, but the aspect I want to stress in this connection lies here: that the advice would be completely pointless and have no value if we could not compel the sex urge to obey the better self (of which no man is *utterly* devoid) and make reason dominant to instinct and mechanism. A man is greater than his glands just as the whole is greater than its part, and if either a man or a woman is to be swayed by every caprice of some gland, better renounce manhood and womanhood at once.

It is here that we may note another important point. Those glands over which we have no control, or very little, are precisely those which have no appreciable effect on character and the moulding of it: they have no moral consequences to speak of. Such are the two parts of the pituitary gland (anterior and posterior): the part of the pancreas which has to do with the production of diabetes (islets of Langahans), and some others. On the other hand, those that have an admitted influence on morality and behaviour in general, and which may lead to various delinquencies (adrenals and sex glands are typical ones) are precisely those in turn over which we can exercise supervision and control. For it is surely admitted anger and rage *can* be curbed. The law among civilized peoples is definite enough that we may not allow our anger to transgress a certain limit—it does not recognize as a plea for exculpation ungovernable temper. Yet there are instances where righteous indignation is not culpable, as when Jesus cleansed the Temple.

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[1] Sir William Osler, M.D., F.R.S., *Principles and Practice of Medicine*, 6th edition, pp. 278-9.

Now it is a very remarkable reflection that our Lord should actually refer to this very subject of whether glandular activity and its effects are within our capacity to control and also should contrast those over which we have no power with those over which we have power. It will be remembered He said, " Which of you by taking thought can add one cubit unto his stature? " (St. Matt. vi. 27). This strikes to the very root of the growth function of the anterior pituitary gland—although, of course, the gland itself is not mentioned. The point is, the uselessness of attempting to influence this particular action of the pituitary, which action, even if excessive, cannot be blameworthy. The other incident which I want to compare with this one is found in St. John viii. 3-11. It concerns one of the glands, the urge of which may be kept in check. The scribes and Pharisees confronted Jesus with a woman taken in adultery. The charge was not denied; the accusers held the legal cards; by the current law of Moses the culprit was liable to be stoned to death. I do not think the story is intended just to show the mercifulness of the Son of Man when He said, "Go, and sin no more." Had our Lord been living in this age, with access to all the modern knowledge about glands, I can very well imagine Him saying in modern scientific language, comparing the two, "Why worry about the anterior pituitary gland? Do as you like, you can't prevent an overactive one producing a giant by abnormal growth. But the sex glands are a different story; you *can* keep these in check if you will. Let their action be governed more by reason, less by emotion; give the brain a fair chance, and above all consult and cultivate your true personality, and you will sin no more." In view of what I have said before, is not this a fair statement? The facts are straightforward; the conclusions are not stretched and warped to fit any particular doctrine, but are merely common sense. Is it not remarkable that the greatest Teacher of all time, not in possession of present-day scientific knowledge, did not make the mistake of confusing whatever controls growth with whatever controls the sex urge? Obviously the essence of modern truth was accurately grasped, that overaction of the one type of gland carries no responsibility whatsoever, while a very grave responsibility attaches to overaction (which *can* be bridled) of the other type.

After what has been already discussed and emphasized it is clear that but little need be said about criminality and its association with glands. It is scarcely necessary to point out there is no such thing as a gland which is responsible for a criminal tendency. Unbridled glands, lack of the proper control of them, may easily prove to be the first step on a path which ultimately leads to a criminal act, but it can never be a legitimate excuse to blame the glands. To do so is but another version of the old story, "The woman whom thou gavest to be with me, *she* gave me of the tree and I did eat"—that of seeking to "shift the blame." Although this story of the Creation and of the Garden of Eden is not accepted literally to-day it still has its ethical value; neither science nor Christianity will condone Adam's way of trying to escape the consequences of his own weakness. Had he been a modern we may easily imagine him charging one or other gland with the responsibility for his lapse, as many to-day no doubt are only too ready to do. Religion requires a man to be manly; tenderness may find a place in his nature, but not effeminacy. A true and right personality can and must rise superior to all such subterfuges.

From the foregoing it will be seen how little the glands furnish any plea for excuse of real delinquencies and probably none for criminality. Environment and upbringing are much more potent factors, and improvement of these is an avowed part of the work of a modern Christian community and Church, though this is not my present theme. The case of the cretin may be deemed to be different because it cannot be assumed to be the child's fault. Any adequate discussion of this aspect of it would, however, lead us straight into the whole problem of suffering and evil, for it clearly falls into the category of disease in general. It is to be observed, however, that this is one of man's brilliant successes, for no child need any longer be afflicted with this disease. It is part of the general incentive to effort which forms so large a part of the education of Christians and scientists alike. If the Christian be taunted with the presence of suffering allowed by a Creator who is believed to be an all-merciful Father and *could* have averted it, we may say we cannot be expected to see what wisdom may ultimately lie behind the scheme of the cosmos.

CHAPTER XI

SURVIVAL OF DEATH

WE are now about to inquire into one of the most fundamental Christian beliefs. It is the belief that some part of a human being's make-up survives after bodily death. Let it be said at once that there are many avenues of approach to this problem, some of which are beyond the scope of the present work. For this reason what space I have at my disposal will be occupied mainly with biological considerations. Perhaps, after all, this will be more acceptable to readers and students because biological knowledge is not so easy to come by at first hand as a knowledge of many of the other sciences.

If we ask the mechanistic or materialistic biologist to state his view of the problem we shall be quite sure there is no prejudice or over-statement. We have already seen that Sir Arthur Keith is quite definite. His words are: "Yet the honest biologist cannot accept, as an explanation of what he sees and knows, a dual theory of the living body. For him spirit and body are one and indissoluble."[1] He compares a human life and the flame of a candle and assures us that when a human being dies there is just as much survival of that life as there is of a candle's flame when it is blown out. There recently appeared a series of short essays by various writers on their beliefs. These are now collected in pamphlet form under the title *What I Believe.* In the second essay Professor Julian Huxley begins, "I do not believe in God, because I think the idea has ceased to be a useful hypothesis."[1] He continues, "Nor do I believe in immortality. A great danger of all religion is that it should embody wish-fulfilments, and the idea of immortality would appear to be merely the rationalization of a wish-fulfilment."[2] There is no need to state the materialist's position in greater detail; it is plain and frank enough, and will form the theme of what we are to discuss in this chapter.

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[1] *Darwinism and What It Implies*, p. 29.

Before passing on to the main argument, however, I should like to point out an interesting allusion in Professor Huxley's essay just cited. On p. 12 he remarks, "It was William Blake who wrote, 'All deities reside in the human breast,' and Jesus himself who said that the Kingdom of God is within us." It is strange that within the limits of a short article a writer should affirm in unqualified language "I do not believe in God" and also "Nor do I believe in immortality" yet almost in the next breath should, with very obvious approbation, quote the words of Jesus, "The Kingdom of God is within you." Clearly, if there is no such being as a God, the Kingdom of so mythical a person is at least equally mythical and there can be no logical meaning in the reference. If, on the other hand, it is intended to show that even Jesus did not believe in anything but a subjective (or in other words, purely anthropomorphic) God and His Kingdom, what are we to understand by the continual references to his Father and the mansions we are to occupy when this life is over? There cannot be the two contradictory interpretations running parallel. This by the way.

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[1] *What I Believe*, p. 9.

[2] *Loc. cit.*, pp. 10, 11.

We now come to ask if biology definitely negatives anything in the nature of a so-called soul and, by implication, negatives also anything even remotely suggesting survival after bodily death. We must at once put out of count all notion of human bodily survival; it has long been known that bodily survival is a sheer physical impossibility and it is only mentioned because I believe there are still a few good people who think the doctrine of " resurrection of *the* body " is tenable. It is quite a different matter affirming belief in the resurrection of *a* body, as we shall presently see.

Our first significant fact concerns that remote time when the foundations, making a science of biology possible, were laid—I mean the time when life appeared on this earth. Although it is more than likely that the very earliest organisms which could be called living were simpler than creatures like the amoeba, we may, without doing any violence to reason, safely build our argument on their characteristics, which are the same for all the one-celled organisms. Some of these features have been described briefly and need not be re-stated. It is upon one of these, however, that we are now concentrating our attention.

It was noted that among all the lowly one-celled creatures the characteristic which perhaps stands out most clearly of all is that of universal immortality. One cell, that is, one whole complete organism, divides into two whole, complete cells. No biologist can say which is parent and which is offspring—the two are perfectly identical. These two divide again; the four divide once more, and if we watched millions of generations we should be no nearer detecting either parent or daughter. Of course if this went on, with no check whatever, our rivers, lakes and seas would become solid with organisms, and as a fact such creatures are destroyed in one way and another in fabulous numbers. From the creature's point of view, however, any and every destruction is accidental and has nothing whatever to do with this peculiar inherency: it does not affect the inalienable right of the organism to immortality. This is Weismann's well-known assertion of the immortality of uni-cellular organisms. Critics attempted to show that in *some* of these creatures (e.g. in the infusorian Euplotes) something corresponding with death seemed to occur; for the nucleus really consists of two parts —a larger and a smaller (the macro- and the micro-nucleus). When two of these organisms chance to conjugate, as they may, the two micronuclei fuse, while the two macro ones disappear. Meanwhile the two cells, having fused into one, proceed to divide into two daughters in the usual way. Some biologists would claim this as an example of some sort of death among these one-celled creatures and that " death of the old morphé and birth of two new ones is involved in this."[1] If this *is* to be regarded as some sort of death, there is still no answer to Weismann's very pertinent remark—if this is death, there is no corpse! But even should we grant this much, the general statement still holds true, that among the earliest forms of life, apart from accidental occurrence, there is no such thing as death. We can fairly say without fear of contradiction, once attain to livingness in those early times, then immortality was not only assured, it was inevitable; there was actually no escape from it in a normal way. The significance of all this is plain enough, that the *idea* of immortality is not the foolish, fantastic rationalization of a wish-fulfilment; it is a scientific actuality. This does not involve any theory regarding the origin of life. We are at liberty, as far as the fact itself is concerned, to believe that life gradually arose as a result of a physical aggregation of more and more complicated colloidal molecules, or that it is a gift, by contact, from the Creator Mind. Nor is the scientific concept altered if we even allow that the taint of death is already falling upon Euplotes. Now it is generally agreed that life has existed on this earth for not less than

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[1] Prof. Julian Huxley, *Essays in Popular Science*, p. 101.

300,000,000 years. The forebears of a creature like the amoeba were probably much the same as those of to-day. These organisms undergo a division into two in considerably under an hour and there are 8,736 hours in a year. This gives us something like 2¾ million millions of generations (or divisions) between those remote days and now. There is every prospect and presumption the same thing will go on for millions of years more. If we may speak of the individuality of an amoeba (and it *is* a separate, distinct and definite creature differing from paramecium, vorticella, trypanosome), then the amoeba of to-day has preserved its individuality throughout this enormous lapse of time. Thus it is easy to see that life (whatever it may eventually prove to be in its real essence) is, *per se*, and of its very nature, an immortal entity. To a Christian there does not seem to be any doubt about the source of life (which to him is God) being immortal, and one would think *a priori* that if He conferred this upon any material aggregates that were sufficiently prepared to receive it, the gift would be an immortal one too. A mechanistic biologist may easily be prepared to go thus far, but the continuation of his argument would proceed along these lines. As the single-celled organisms found it an advantage, when they divided, to remain in contact and form colonies, say, of a few hundreds of cells, they would be faced still with the same problem, that the surface area of a body does not increase in the same ratio as the volume or bulk of it. A partial solution of this difficulty would be to make the surface irregular, much as the surface of the brain is increased relatively to the limited room it has for its housing. This, however, would be but a partial solution and the difficulty would best be met by a method of division of labour among the cells. For example, the setting aside of cells which would absorb food would lead to the formation of a tube with modifications (stomach, intestines, etc.), and by this device the surface could be enormously increased. Among such cunning methods sex appeared and our biologist would point out that as these various complexities arose, so death entered the arena, and while the sex cells continued the "stream of life," the body died: the more complex the organism the more certain did death become. The mechanistic biologist, like Sir Arthur Keith, asserts that he claims immortality for man, but not a personal immortality, for his meaning is that mankind will continue to occupy the earth for millions of years to come. "It is in this material sense that the biologist regards man as an immortal being; we survive, if we survive at all, only in the lives of our children and of their descendants."[1] Those human beings, therefore, who chance to die childless have irrevocably and for ever forfeited their immortality—they have not even the satisfaction of reflecting that "The dewdrop slips into the shining sea."

At this point we may try to look a little deeper, for after all, this is quite a surface view. It is the obvious one—the body (soma, it is called in biological language) appears to die, while the only continuation of its life lies with the germ cells. An eminent zoologist puts the problem in this way: When John Brown dies, two things have been lost to our world. 1. The actual substance of his body—the protoplasm and all the tissues composed of it, such as brain, muscle, bone and so on. These disintegrate and in a very short time no longer exist as protoplasm, but are resolved into much simpler compounds, or even into elements. So far, everyone is in general agreement. 2. John Brown's individuality, his character, his personality, everything which made him not only a man but an individual man, dies also.[1] In this postulate, however, the scientific world is very far from agreement, as will be recalled on glancing again at what has already been said about the brain, the mind and personality. Enough was there said to show that the most eminent authorities of to-day disagree with the statement and claim above. Yet it is set down as assured proof, as though there were no choice but complete acceptance. Indeed, it is the very point at issue and according to the evidence of the authorities adduced, the doubt about the death of John Brown's *personality* is growing more and more. The mechanistic biologist just asserts that John Brown's personality *cannot* survive his somatic death. Professor Sullivan warns us to be cautious. " Both the material universe and the mind of man are very mysterious things. At the present time it is only an inadequate mind which is confident that it knows what is impossible. There was never a time when hearty dogmatism and loud confidence were more out of place."[1] The unsatisfactory thing about the wiping-out of a personality is that such interpretation is too facile, too easy, and smacks too much of the obvious.

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[1] Sir A. Keith, *Darwinism and What It Implies*, pp. 24, 25.

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[1] Prof. Julian Huxley, *Essays in Popular Science*, pp. 94, 95.

As this question must be raised again, and as the above is rather in the nature of a digression, we must proceed to further significant biological facts. We have seen how the one-celled creatures (the Protozoa, as they are called) possess a true immortality and that as they became more highly organized by colonies of cells living as one creature, and parts becoming specialized for different kinds of work, so at that time death began to creep in. It is almost as though the larger and fuller existence had to pay the price of individual sacrifice of life. But is that the complete story? Not by any means. For lower organisms show a remarkable characteristic. If we take, for example, certain small flat-worms and cut them into pieces, providing these are not too small, each piece will regenerate a complete creature. Stranger still, this capacity is retained (although not as completely) in much higher organisms. Thus if the limb of a newt be removed in a certain way (too involved for a popular exposition), the limb grows again. So, too, in certain worms, if the last fifth of the body be cut off, this small piece will, in ninety per cent. of cases, develop a new head end from

[1] Prof. J. W. N. Sullivan, *Gallio, or The Tyranny of Science*, p. 46.

the cut surface. Again, when spiders are casting the outer shell, as they do periodically, it happens not infrequently that a whole limb may be left behind in the discarded shell, whereupon the spider proceeds to grow a new leg, which, however, may only attain its proper size after one or two more moults. Even so highly specialized a structure as the lens of the eye of a newt will be regenerated after its removal. Now biologists have their own way of explaining such remarkable happenings as these along with those of normal development, but other things may be said of them. For, the moment we begin to try and look on these facts in an interpretative sense, we may at once realize that these regenerative efforts, so to speak, are nothing else but relics in reality of the lost somatic immortality, and an attempt, as it were, to recapture a fading and failing capacity. Nothing is so certain as the fact that life, as it left the hand of its pristine source, was immortal—it makes no difference whether we call the source God or not.

But it will be countered, even if we accept this view, then clearly immortality *has* been increasingly lost, until, in the highest organisms of all, it has been completely and irrevocably forfeited, for even the regenerative capacity has gone. Incidentally, this is not quite true, for, although such creatures as mammals do not regenerate limbs, eyes and other tissues, a faint remnant, represented by the healing and repair of wounds, still lingers. This is the plain, simple view of the mechanist, and illustrates how the bodily part of an organism is liable to become more and more the victim of a universe that knows no mercy. For even if mechanical devices appear here and there which for a time resist nature's attacks, living creatures must in the end succumb to the continual processes of universal degradation that go on. In other words, living creatures are constantly at war with their environment, with nature. This is shown by the continual need to hunt and forage for food, to shelter from unfavourable or harmful influences, to fight with or flee from enemies, and so on. "The essential difference between the inorganic unit and the living individual is that the activities of all living things tend towards some end and are not easily diverted from achieving this end. . . . What differentiates a living thing from all inorganic objects is this persistence of striving, this effort towards the expression of deep-lying instinctive tendencies, which we know to be the inmost core of our own being."[1] Again, the same author continues, "The objective purposiveness of organic activity is not, like the purposiveness of a machine, a fixed and automatic thing, but on the contrary is self-regulatory and adjustable to a wide range of circumstance. A completely blind, unalterable and automatic activity would soon destroy itself."[2]

Accepting then the fact that bodily survival after death cannot be entertained (for the door is not only locked, but barred) the above restatement of the inadequacy of mechanistic philosophy opens a more promising avenue. Living things tend towards some end and are not easily diverted from achieving this end. It could not be more clearly seen that we are here in the presence of a definite purposiveness and neither reflex acts nor the tropisms of Loeb touch the problem in the way of ultimate explanation. Our particular problem just now is that the primitive creatures lost their capacity for somatic immortality as they became more complex. We have just seen that this was a prize not to be relinquished lightly, and the facts of regeneration plainly show us that organisms tried, as it were, to keep a grip on the gift. Success, however, seemed to recede farther away, but, not being " easily diverted from achieving this end," by continued " persistence of striving " an alternative avenue began gradually to open. True, the foundation stones were laid down long before the nature of the eventual structure could be revealed and the early steps of themselves were not enough to achieve the end. In spite of all the biological teaching stressing automatism, tropisms and the like, living creatures maintained this characteristic of trying to find an alternative. What was it?

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[1] Dr. E. S. Russell in *The Study of Living Things*, p. 56.

[2] *Op. cit.*, p. 57.

Without entering the rather questionable territory of the more lowly organisms, I think we may say the first definitely perceptible step was taken when the foundations of a nervous system were laid. Not that these organisms would or could realize the eventual significance of the move. All the same, it *did* happen that here was the precursor of mind, a quality that baffled no less an authority than Sir Charles Sherrington to explain in terms of mechanism. The mechanism is there, but as in other instances (the origin of otoliths and their diversion to a definite use is a case in point) it is impossible to foretell what accessory function may be added to the original one, and indeed become the one of most value. Thus here was a vehicle through which ultimately mind could find a channel that would be equal to displaying it. We know, at least in a partial way, how successful the adventure has been and it would be difficult for anyone to say what other measure could have replaced this. If the importance and significance of this be belittled by affirming that the higher animals have minds which may fairly be assumed to be competitors of man's mind, the reply is that even the highest animals' minds are very inadequate (compared with man's mind) to assume the function which was shortly to be the possibility offered to man's. If there should appear to be any doubt on the point, the same cannot be said about the quality that we call personality, for in this respect, man *is* in possession of a characteristic that stands unique: those best qualified to judge are agreed on this point.

Now we have seen that the universality of immortality was gradually lost as organisms became more highly developed; step by step it has receded farther from re-attainment, that is, the original bodily immortality. But precisely as this had to be relinquished and also running parallel with the loss, there began the first fitful gleams of a rudimentary mind, or at least the scaffolding for the structure which was destined to reveal it. As it has just been shown, the *essential* distinction between living and non-living is this remarkable, persistent striving of the one towards some end—it is not easily diverted from its object. The whole history of life points also to this striving not being confined to the immediate present, to pressing needs at that moment. For we have no less seen in an earlier chapter that living things do things for the good of themselves and for the good of the race. It might be contended that the "good of themselves" could easily be concerned with the present alone, but the moment we introduce the idea "good of the race" there is the future implicit in the very notion. When we add to this that "the objective purposiveness of organic activity is self-regulatory and adjustable to a wide range" we not only understand more fully the meaning of the good of the race (so necessarily involving futurity), but we also perceive that the weaving together of these facts begins to take on a compelling aspect. Thwarted of the capacity to retain its hold on the immortality bequeathed to life, Nature seemed almost compelled to refuse defeat and must needs set about finding some other means of restoration. We need only spend a very short time in a rapid and broad view of living creatures as the marvellous panorama of advance and achievement unfolds itself through geological ages. A vestige of a nervous system appears; it is found to pay; it develops so rapidly that it outstrips somatic development; mind is forged on the anvil of time; so successful is it that it takes the lead: and at last there emerges a distinct, unique and dominating personality which is able to do what nothing before has achieved—put itself into true contact with the source of life. Because this contact is of the same nature as was that creating life when it first began, the personality comes into its own and regains the lost capacity by shedding its mortal garment and reaching out to a refinement impossible while still enchained in a protoplasmic prison. No wonder Ronald Macfie — poet, doctor and scientist—could sing:

> What an adventure it will be to die
> And in a magic moment be reborn,
> Passing upon the pinions of a sigh
> From night to morn:
> To wake from sleep and find
> The eyes no longer blind,
> The swift, emancipate, immortal mind
> Flashing and flaming in an ampler wind.

It is hardly possible to close this chapter without a brief reference to the Modernist's way of looking at things religious. Old interpretations and views, especially relating to the Old Testament, have been recast. It is probably too much to expect that everyone will endorse the newer teachings: some were " brought up " among literal meanings in everything biblical, and consider it shockingly irreverent to doubt that Moses wrote the Pentateuch, or that the story of creation in Genesis is word for word true. But religious beliefs, equally with those of science, must be progressive and conform to the ascertained knowledge and spirit of the times. The creation story, if scientifically untenable, is yet one of the gems of literature, and we treasure it as such. At the same time there are remarkable flashes and germs of truth in it if viewed in broad outline. Design, purpose, a directive Mind behind all in the visible universe breathe out in every line. They must form the kernel of religion and there are many scientists to-day who firmly hold that modern scientific knowledge (not in the hypothesis stage) is a sure revelation of the finger of God. In this sense there can be no " Religion without Revelation "—for Nature herself is a continual revealing. In a work devoted entirely to mechanical and mathematical expositions of biological subjects we read, " Time out of mind it has been the way of the ' Final cause,' by the teleological concept of ' end,' of ' purpose,' or of ' design,' in one or other of its many forms, that men have been chiefly wont to explain the phenomena of the living world; and it will be so while men have eyes to see and ears to hear withal. It was the old Hebrew way and has its splendid setting in the story that God made ' every plant of the field before it was in the earth, and every herb of the field before it grew.' It is a common way, and a great way; for it brings with it a glimpse of a great vision, and it lies deep as the love of nature in the hearts of men."[1] This, be it noted, is from the pen of one of the most eminent of our living biologists, whose opinions are more than respected by all biologists and whose work is classical. Our author continues, " Like warp and woof, mechanism and teleology are interwoven together and we must not cleave to the one and despise the other; for their union is ' rooted in the very nature of totality.' "[1] Not content with this, at the close of the work just quoted, Sir D'Arcy Thompson tells us, " For the harmony of the world is made manifest in Form and Number, and the heart and soul and all the poetry of Natural Philosophy are embodied in the concept of mathematical beauty. A greater than Verhaeren had this in mind when he told of ' the golden compasses, prepared in God's eternal store.' A greater than Milton had magnified the theme and glorified Him ' who sitteth upon the circle of the earth ' (Isaiah xl. 22) saying: ' He measureth the waters in the hollow of his hand, he meteth out the heavens with his span, he comprehendeth the dust of the earth in a measure ' " (Isaiah xl. 12).[2] In this connection it is worth noting that Plato says somewhere, ὁ θεὸς παντὸτε γεωμέτρει, that is, God always geometrizes, an assertion that is curiously in agreement with Sir James Jeans when he says that behind all the physical phenomena is a mathematical Mind. If we see this everywhere in things physical, we also see it in living organisms where form tends to be so beautifully adapted to function. Just as, however, we cannot believe that the Being of God begins and ends in mathematical concepts, so we leave the mathematical realm when we come to a realization of man's personality. No matter how much we may appreciate orderliness and arrange things with more or less geometrical precision there is so much above and beyond this bound up with our personalities that we are prompted to ask, whence all this? The reply, in the last resort, is, that personality has fought its way back to the attainment of what was lost, it has climbed to the capacity for the spiritual, and its sure possession and inalienable heritage is an immortality that is *personal*. The climb to so lofty a status is beautifully expressed in a stanza of a poem to which reference has already been made:

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[1] Prof. Sir D'Arcy Thompson, *Growth and Form*, p. 3.

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[1] *Loc. cit.*, p. 5.

[2] *Loc. cit.*, pp. 778-9.

A firemist and a planet,
  A crystal and a cell;
A jellyfish and a saurian,
  And caves where the cave-men dwell;
Then a sense of law and beauty,
  And a face turned from the clod—
Some call it Evolution,
  And others call it God.

Which shows that even a scientist can appreciate values and find a place in Nature (and in man) for God.

CHAPTER XII

THINGS PSYCHICAL

PSYCHICAL research has been regarded by many with a very suspicious eye. There are those who consider it a dangerous and dubious prop by which to support any Christian beliefs. They are satisfied (without a fair investigation) that, although pretending to be a scientific pursuit, psychical research lives in an atmosphere of credulity, deceit and fraud. This accusation is both unfair and untrue. The following list of names is enough to substantiate this statement: Sir Wm. Crookes, Sir Oliver Lodge, Sir Wm. Barrett, A. R. Wallace, Wm. James, F. W. H. Myers, J. A. Hill, Ed. Gurney, Hodgson, Murray, Richet, Reichenbach, Flammarion and many, many others. There is no space in one short chapter to do more than give these names as quite enough guarantee, not only of good faith, but of scientific competency as a guard against fraud. There are those also who hold that it is immoral to have anything to do with so-called spirits—to say it belongs to the "occult" is enough, it is contrary to Christian teaching. Yet the Bible, from Genesis to the Revelation, teems with incidents which have their exact counterparts in modern experiences

—the visions of the seers, voices heard and accepted as genuine from the earliest times, priests consulting Urim and Thummim (which many believe the equivalent of crystal-gazing), the appearance of Samuel, the appearances to Peter and to Paul, and of our Lord to the Apostles and to the brethren, the incident of His baptism, and many others. Classical history tells the same story—outstanding is the daemon of Socrates, which corresponds to the guide or "control" of the modern medium. Socrates affirms his daemon never once led him astray or made a mistake. If we accept Biblical and classical history, are all these to be set down as intended to be merely allegorical? Paul in particular, a cultured, intellectual figure, familiar with Greek philosophy, practical and matter of fact in all his teaching, can scarcely be fitted into such a picture.

Coming down, however, to the present day, let me say at once that the ordinary spiritualistic teaching and its inception and practice as a religion hold no attraction for me. The foregoing is introductory to the one question—has modern psychical research helped towards the belief in, or established the fact of, human survival?

First as to the alleged facts—the phenomena, as they are called—for there are still those who, while apparently ready to allow that we can rule out active and deliberate fraud and deceit, contend that these are nothing but tricks of the subconscious (or subliminal) mind. It would be impossible, within such narrow limits, to show how untenable this is by the citation of definite cases and incidents, for they would have to be many. The best answer is a reference to two authors and investigators. The late Professor Richet was a lifelong physiologist. As such it was his normal habit to regard function as entirely dependent upon (or at least in closest correspondence with) structure: the mind, for instance, is a direct result and outcome of the activity of the brain: the personality is somehow purely a result of some mechanism. The consequence is that clairvoyance, clairaudience and the like are most likely to be hallucinatory. Anything a medium tells a sitter is either shrewd guesswork, information obtained through normal channels or by fraud and trickery, direct mind-reading (known as telepathy) or some such means. Now the significant thing about Professor Richet is that he devoted over thirty years to an intensive study of the so-called "spiritist phenomena." His book, *Thirty Years of Psychical Research*, not only admits the reality of the phenomena, i.e. that they *do* occur, but stoutly maintains their actuality and also scouts such explanations as fraud or coincidence and chance. The book is not only large and exhaustive; it has already become a classic. Richet does not believe the facts prove survival, but instead postulates the existence of a remarkable faculty which he calls cryptaesthesia: the word, of course, simply means "hidden feeling." Thus the term *explains* nothing, and it seems illogical and *extremely far-fetched* to assume the existence of a faculty the use of which is exclusively confined to the reception and supposed explanation of these supernormal phenomena. We can trace the evolution of other sense organs, step by step, see their increasing value as they become more perfected (sight, hearing, taste, etc.), and see also how valuable they would be during the incessant struggle for existence, where every small advantage counts heavily. There seems no reason whatever, no incentive, so to speak, for the origin and development of a faculty such as cryptaesthesia, which would (on Richet's hypothesis) have appeared and have been developed *solely* for the purpose of producing and then elucidating such remarkable happenings. It would be difficult to think of anyone *better* equipped both naturally and by scientific training to detect any flaw in the alleged character of the incidents, and clearly a man of his scientific standing was exposing himself to the ridicule of other scientists if he subscribed to alleged incidents as facts and then found he had been incautious or even badly "fooled." His book contains hundreds of these incidents where the information given could not have been obtained by any ordinary means otherwise known.

The second author is my very close and valued friend, Mr. J. Arthur Hill. His contributions reach well-nigh a dozen books besides articles and lectures. He has been in intimate touch with Sir Oliver Lodge for quite thirty years and is twice quoted by Richet, who regarded him as an exceptionally accurate and reliable observer. The special points I want to stress are these: there could not be a more unemotional investigator; indeed, sittings are always recorded verbatim in shorthand and he is busy enough to quell any sensational response; his analyses are logical to a degree; he began these investigations while bedridden and in a spirit of curiosity. As a fact he was a complete sceptic and at that time contributed to the Rationalistic press. His experiences have completely altered his views and he has been satisfied for many years that attempts to explain these phenomena by the various other means suggested are much more "far-fetched" than the spiritistic interpretation. Most people who have seriously studied these manifestations with anything like an open mind are prepared to concede the fact of telepathy. Mr. Hill points to many cases in his records (verbatim, at the time of the sitting, be it remembered, and *not* "touched up" afterwards) where no living person could know the alleged incidents, but which on prolonged and tedious search turned out to be verifiable from records which were not then known to exist. If telepathy be the means by which a medium gains the knowledge, and no one living exists, then necessarily the telepathy is from the living mind of a body that no longer lives. In view of what has already been said about personality, it is worth noting that in some of these cases little tricks associated with the personality concerned sometimes appear and confer a startling reality, one which writing cannot convey.

It is disappointing that a citation of even one good case would entail exceeding the limits allowed me, but perhaps the course adopted is the wiser one, seeing that such excellent accounts are readily available. (See, in particular, Mr. Hill's books, *New Evidences in Psychical Research; Psychical Investigations; Experiences with Mediums; Man is a Spirit; From Agnosticism to Belief; Psychical Science and Religious Belief*. Many other remarkable books exist, notably those by Sir Oliver Lodge, models of scientific procedure.)

My choice of the two authors has been deliberate—first, a physiologist who assures us there is no escape from the phenomena as being real and factual, whatever the explanation may be; second, a cultured, practical observer with a typically scientific mind who has, in spite of preconceptions, been driven from the trenches of unbelief to the larger hope of Christianity.

CHAPTER XIII

ON PURPOSE

Purpose is our theme, and throughout the history of human thought it has proved itself to be a great one. We have just seen what Professor Sir D'Arcy Thompson says about the teleological concept of "end," of "purpose." His conclusion is that "it is a common way, and a great way; for it brings with it a glimpse of a great vision." He does not even regard the existence of purpose as arguable—it is there in all nature, plainly to be seen. The modern mechanist will have none of this. To him, the evolutionary process reveals nothing but a vast self-created, self-attuned, self-progressive machine. Naturally, denial of the existence of a God involves all this and the very notion of purpose becomes an absurdity.

Now in a problem of this magnitude and importance we cannot discuss it without introducing its alternative and contrast. For if the evidence adduced be said to be inadequate, it is only natural to ask—what then? There is another reason, because even if our evidence be regarded as inconclusive, the alternative explanation may quite conceivably have been in a still worse position; in which case we are justified in holding to the better alternative. The alternative to the existence of purpose in the scheme of the cosmos is chance. It is what Bertrand Russell calls a "fortuitous concourse of atoms." If we allow, for the moment, that things physical began in this fashion, the moment the concept of life enters the picture we must certainly rebel, for if fortuity reigned, one cannot imagine how inheritance came to have a place, since this is the very antithesis of fortuity: it is orderliness which cuts at the very root of chance. To be a consistent philosophy fortuity must be obvious throughout, from beginning to end. It may be noted here that some of the mechanistic biologists, while still stoutly denying all evidence of purpose, grudgingly concede that the general trend of evolution appears to have some sort of direction about it.[1] I may be doing them an injustice, but to me this seems to be suspiciously like hair-splitting and quibbling over a word. For *any* sort of direction implies a goal to be attained and towards which there must be some striving: which is exactly what E. S. Russell tells us on pp. 56 and 57 of *The Study of Living Things* (already quoted).

At this point we may profitably ask what the greatest naturalist of all time has to say on the matter. Sir Arthur Keith unhesitatingly claims Darwinism as the foundation of modern materialistic teaching. Of all men, there are few who would accuse Darwin of writing what he conceived to be untrue—deliberate deceit was *not* one of his ways. In the concluding chapter of the *Origin of Species* he says, "I see no good reason why the views given in this volume should shock the religious feelings of anyone. . . . A celebrated author and divine has written to me that 'he has gradually learnt to see that it is just as noble a conception of the Deity to believe that He created a few original forms capable of self-development into other and needful forms, as to believe that He required a fresh act of creation to supply the voids caused by the action of His laws.'"[1] The striking fact about this quotation and the introductory remark is that Darwin is in complete accord with the opinion of the celebrated divine. More than this, the last sentence in this work (with additions and corrections to 1872) reads as follows: "There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, while this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been and are being evolved."[2] The main point I am now stressing is this, that the *author* of the theory called Darwinism most surely did not believe that "what it implies" is the same as Sir Arthur Keith's views of what is unavoidably implicit in it. It need only be remarked that the co-discoverer with Darwin of the principle

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[1] Prof. Julian Huxley, *Essays in Popular Science*, p. 157.

[1] Charles Darwin, *Origin of Species*, 6th edition, p. 422.
[2] *Loc. cit.*, p. 429.

of Natural Selection is even more emphatic. It comes to this, therefore, that if there *is* a Creator, there must of necessity be purpose behind all that was created. An active, definite creation by some Being which showed no object, no aim, would be as near to a contradiction in terms as we could get. I am not advancing this as a *proof* of any purpose, but it clearly compels us to choose between purpose (and therefore a purposive agent) and stark chance.

Having cleared the ground thus far, the question of purpose can be more directly addressed. There are many learned people who are just as competent to form an opinion as are the mechanistic biologists, and who consider that the whole upward trend of evolution points quite conclusively to a scheme whose very essence is purpose. Especially if we accept the concession that in the process of evolution " we can and must on the evidence say that it has *direction* "[1] (italics not mine), most people would agree that further proof does not seem to be urgently needed. There are those, however, who may prefer direct references to definite instances that are more specific. One such has already been given when discussing the division of cells. The elaborate mechanism of the spindle will be remembered, and this fact alone would prejudice many against the mechanism being mere chance. It may be said that the eye is one of the most intricate organs we know, yet it is not unlikely that it has developed from a mere pigment spot. True, but the rudimentary eye in those early days was not a matter of life and death to an organism. The way a cell divides, in the matter of its distribution of chromosomes, *is* of the most vital importance—it means life or death. Theoretically speaking, an organism, say, with a hundred chromosomes, may have these distributed in an enormous number of ways, in only one of which could there be a fifty-fifty arrangement; all others would be irregular, and irregularity means the degenerative disease cancer, which in turn means death. Put into plain language, deviation from normal, regular division is self-destructive.[1] We are asked to believe that a purely mechanistic evolution, out of the numberless ways of division, chanced upon the correct one very early if not in the first experiment, for the destructive nature of a fault would not allow of trial after burial. The " chance " hypothesis in fact becomes more nebulous the more we think about it.

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[1] Already cited, *Essays in Popular Science*, p. 157.

Another convincing instance is referred to by Sir Arthur Eddington. We need only recall what was said earlier about the ninety-two elements following a rigidly definite order (1, 2, 3, 4, etc.) from one to ninety-two and remember that carbon is numbered 6 in the series—the element that is so arrestingly associated with and essential to livingness. Eddington's words are: " We can scarcely call it an accident that among the integers there should happen to be the number 6; but I do not know how otherwise to express the fact that organic life would not have begun if Nature's arithmetic had overlooked the number 6. The general plan of ninety-two elements . . . contemplates a material world of considerable but limited diversity; but the element carbon, embodying the number 6, and because of the peculiarity of the number 6, rebels against limits."[1] This is a general, but quite accurate, statement of the problem. If we look a little more closely we shall realize its fuller significance. Beginning with the simplest element (hydrogen) and passing up the series, we find the properties and characteristics changing in a gradual way. As far as the physical world is concerned, carbon just takes its place among all the others; there is nothing to suggest it possesses any striking properties which mark it off from others in any particular way. It is just the element 6 in a series of ninety-two. The moment, however, we enter the chemical arena, there is a startling and revolutionary change, Its activity, its capacity, its potentiality leap into a significance possessed by no other element; while its association with life (which no other element can supply) makes it the most unique physical entity we know in the whole universe. No one, on *a priori* grounds, could have predicted or even suspected such significance to be found for the integer 6, over and above the capacities of any other element, or indeed of all the other ninety-one together. The complete unexpectedness of it would almost seem to show in itself that its capacities cannot be accidental.

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[1] Cf. E. B. Wilson, *The Cell in Development and Inheritance*, p. 98 ff., and various text-books on pathology.

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[1] Sir A. S. Eddington, *Swarthmore Lecture*, p. 14.

It may justly be said that, if one thing more than another stands unique and in majestic aloofness, *physically* speaking, in the cosmic scheme, it is the element carbon. There does not appear to be a single assignable reason for such remarkable properties as those possessed by carbon (over and above and totally distinct from others) unless it were deliberately provided in a planned scheme that it should in due time play the role it does. Nor is this any more fantastic a claim than when Sullivan says the electron behaves as if it had foreknowledge and could calculate to an amazing extent. Yet for thousands of millions of years, in our own solar system alone, the carbon atom has played its part just like any other atom, rather like silicon in its habits, as it were, until life appeared. The opportunity arose, no element save carbon could supply the foundation for that astounding quality we call life, but it was there, ready to hand when the need came. The story of carbon is more gripping, more breath-taking than any fiction. Yet there are those who refuse to see any significance in this, or any purpose behind it all.

Before going on to my third illustration, we may look at what Sir James Jeans has to say about the whole subject of chance. He has been discussing the subject of entropy, and when this is perfect he calls it the " final state." It would take up too much space to describe this argument, but he reaches this conclusion: that the odds against the universe having come to this final state are " something like $10^{420,000,000,000}$ to one." This number means 1 followed by 420,000,000,000 (i.e. four hundred and twenty thousand million) noughts. If we filled books with nothing but this number of noughts following the figure 1, the books would fill a church. For all practical purposes we may say the odds are infinity to one. Now comes the important point for us, "the mathematical specification of a fortuitous state (i.e. things having arisen by chance) is precisely the same as that of a final state, and this enables us to dismiss the fortuitous conception of the universe as being entirely out of the question. Everything points with overwhelming force to a definite event, or series of events, of creation at some time or times, not infinitely remote. The universe cannot have originated by chance out of its present ingredients, and neither can it have been always the same as now."[1] As far as I am aware no one has challenged this mathematical conclusion, and if a Creator is a mathematical necessity, the hypothesis of a blind chance becomes a mere farce.

Our next illustration must suffice, although the number could be multiplied. It concerns the common compound we call water. The chemist would say it is among the simplest of the molecules—two atoms of hydrogen combine (or link up) with one atom of oxygen and we express this fact by writing H_2O. Now this substance, water, is so universal and our uses of it so multitudinous that we rarely stop to ask about its remarkable and indeed unique properties. Other substances, solids, liquids, gases, expand when heated (consequently a given bulk occupies more room) and contract, or shrink in bulk, when cooled. Water follows the same rules except in one regard. As we cool it and reach the point 4° Centigrade the water invariably expands. In a pond, exposed, say, to a cold wind, the surface cools first. If the bulk of it is at 10° C. and the surface is chilled to 8° this surface layer sinks to the bottom. The cooling goes on, followed by the sinking of the new surface layer until all the water is in the region of 4° C. At this point the sinking ceases for the surface layer now expands and *remains* on the surface. At 0° C. the surface becomes solid, i.e. ice, and being expanded, and therefore lighter, ice forms always on the surface. The increase in thickness of ice occurs in the water in contact with the ice sheet, that is, the topmost layer of water. As ice increases in thickness it more effectually prevents the water below losing what heat it still has and thus cold must be very intense and prolonged to freeze solid a pond say only a couple of feet deep. Other liquids do not behave in this remarkable way: when they reach their freezing point they do not expand but continue to shrink, and thus the whole of the liquid freezes solid at the same time or begins at the bottom. Why this unparalleled exception in the case of water? If built on a mechanistic plan, a fortuitous method, is there one single reason why water should not behave in this physical respect exactly as other fluids do?

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[1] Sir J. H. Jeans, F.R.S., *Eos, or the Wider Aspects of Cosmogony*, p. 55. To-day and To-morrow Series.

In the light of the above, think of the consequences if water *did* behave in this respect as do other fluids. Oceans, seas, lakes, rivers would be solid ice and no living organism could exist. Since it is universally agreed life began in the sea, if water had not had this uniquely peculiar property, life could never have begun, much less could it have developed and evolved to higher forms. Can we still believe this was an odd accident, an unexplainable freak on Nature's part?

Again, apart entirely from the fact and its significance just discussed, of all the thousands of possible liquids other than water, there is not one which would seem to have the faintest prospect of supporting life. Moreover, every tissue of every living organism contains large percentages of water as an essential ingredient in its composition. We need only try to imagine the place of water being taken by, say, one of the series of alcohols, one of the hydrocarbons, one of the benzene group, etc., etc., and we see how literally impossible *any* substitution becomes. The liquids just mentioned occur in groups, and while the individual ones are similar to others in the same group and, as it were, show gradation, there is no other liquid even remotely like water: it stands alone.

The instances just considered do not by any means exhaust the list, but these will show the general trend of the argument. It will be noticed they are all intimately associated with life processes—carbon, the spindle of the cell, water. Of these, carbon and water are absolutely essential to life as we know it, that is terrestrial, somatic life, while the presence of the spindle has doubtless had a profound importance in determining the earliest directions in which evolution should move. It is a legitimate question to ask, How comes it that the two most fundamental necessities of life should depend upon two bodies which so markedly possess characteristics above and beyond those of all their congeners? Moreover, these extra properties are exactly those which *do* provide the great essentials for livingness. The properties of these bodies and the demands made by anything that would live dovetail so perfectly that were it in any other connection it would be universally agreed that here was a clear case of purpose and design—a thought-out plan. The mechanistic biologist says it is solely a question of adaptation, but adaptation fails to touch the fringe of an approach to explanation. For adaptation in its very nature and connotation is a gradual process and implies repeated and prolonged trial, and we cannot imagine any complex molecule which was nearly alive making trial of this and that. As for the origin of the correct complex molecule, the very beginning of its up-building would depend upon the carbon atom being there, ready, when wanted; it could not be a question of making shift with some other atom until the carbon one happened to be available. Add to all this the unthinkably great odds against the right combinations, and so on, if we invoke the "fortuitous concourse" hypothesis, and we see with Jeans that such a conception is "entirely out of the question," and that "everything points with overwhelming force to a definite event of creation." Once admit this we cannot escape the conclusion that the whole universe is dominated by purpose, permeated with it through and through. If this is so, we can see (as yet) no higher achievement of this purpose than humanity; for the future, "it doth not yet appear what we shall be." Professor Julian Huxley, in the work I have so freely cited, says, "If there is a God, He must be all-powerful; if He is all-powerful, He could have prevented the war . . ." and so on to an infinity of useless speculation (p. 158). This is true *only* if man is a pure automaton, circumstanced completely by everything about him, great and small, and with no trace of freewill in his nature.

The final choice, then, would seem to lie between chance and purpose; between a merciless, paralysing, deterministic philosophy or fate and a destiny larger than terrestrial environments can provide, a destiny sponsored by a purposeful God. On the one hand Christianity can have no meaning, on the other it is meaningful to its last utterance and teaching. It is strange that while physicists as a whole are condemning determinism even among the elemental atoms and electrons, the mechanistic biologist still clings to this philosophy. Let it be said we should do the biologists a grave wrong if we belittled their splendid recent work and research, and Professor Julian Huxley is well in the van, but we believe the interpretations of these devoted workers are wrong. A frank, unprejudiced estimate of the most recent findings of science seem so effectually to rule out chance that we must whole-heartedly agree with Macfie when his soul poured out:

> If Chance can dance the dust afar
> In myriad motions to a star,
> If Chance can mould,
> With pollen gold,
> The silken seeds where lilies are,
> If Chance one daisy can unfold,
> Then God the hand of Chance must hold.

CHAPTER XIV

EPILOGUE

SUCH a survey as we have just made almost of necessity means that we must make some attempt to gather up the threads we have disentangled and see if they can be woven into any sort of pattern which possesses any significance for a Christian. In all likelihood the ways we have traversed (the biological) will be somewhat unfamiliar to many, but it is hoped that the descriptive parts have been presented in a simple enough form for most to understand. Even if it should mean a rather close application for some, it is believed that a little concentration will be repaid because the more fully a fact is appreciated, the clearer becomes its interpretation and hence its value as a link in the chain. There can be no manner of doubt that to-day this is a very sick world—whole nations are "jumpy" and peoples "nervy." Few will be disposed to disagree when it is said that a potent remedy is urgently needed, and many of us are fully persuaded that the sovereign cure lies in Christianity—not as plasters or other outward application, but inwardly in frequent and copious draughts.

Once true absorption begins, the outward transformation will follow readily enough.

It is my considered conviction that all this post-war unrest, revolutionary proclivity, and the holding of individual life and effort so cheaply, have as one of the main roots the blank denial of the existence of God. This denial is based primarily on the supposed verdict of science—we are continually having it dinned into our ears that there is neither need nor room for a Deity; that life is nothing but a certain complexity attained by a mad dance of atoms until by chance large colloidal molecules formed; that all the marvellous intricacies of life are only a series of haphazards; and that as a logical sequence no such entity as a soul can be found. Thus we are mere flotsam and jetsam to whom Gray's lines may apply:

> Alas, regardless of their doom,
> The little victims play!
> No sense have they of ills to come,
> Nor care beyond to-day.

The contention throughout this work has been that this is *not* the verdict of science, but that the more our knowledge grows the more it is daily telling us that such a conclusion is both premature and untrue. For first we are on solid ground in affirming that whatever further disclosures are in store regarding atomic structure, we can never return to last century's conception of solid material. The whole physical universe is immaterial to the very core, as immaterial as any conception of the spiritual ever framed; waves, group waves, are the most substantial things we can find. More than this, guidance is an entirely inseparable characteristic; group waves and guidance seem to be linked in the same sort of unity as space and time are in the space-time continuum, each complementary to the other. Thus, at the outset of our inquiry we are faced with spirituality and guidance—more significant pointers it would be difficult to find. Again, knowing from the second law of thermodynamics that the universe is running down and must at some future time lie at a dead level, with no trace of any potential in it, we are compelled to assume a beginning. But how? Physical science does not even attempt to tell us except to suggest the possibility of a *chance* occurrence of density somewhere and somehow. Sheer hypothesis! and unsupported by any fact. Besides, enough evidence is given to rule out chance. All science can say is that the universe began. We think we are on firm ground when we say, "In the beginning was Mind and the Mind was with God and the Mind was God." He is the source of energy, and all matter is energy. Even in the physical world we saw that mere contact (e.g. the instance of platinum) can and does produce stupendous effects, and who shall say what a God-mind cannot do by contact?

So much for things physical. Leaving these, we pass into the realm of living things, and here the difficulty of explaining the transition, and the after-action of organisms, becomes much more acute (not less) on a mechanistic philosophy. Many evolutionists to-day believe that we must regard mutants as far more potent factors in the upward climb than can be claimed for small summative variations. There may be truth in this, but, taking the spindle of a dividing cell as an example, it seems incredible that so elaborate a piece of mechanism should appear complete, unbidden and in perfect working order. A gradual development of it from bits of chance threads is unthinkable, for imperfection means inevitable destruction of the cells and the story of evolution could never have been told. The chances of hitting upon the exact necessities seem too remote to be entertained, and especially so if we couple with this mechanism the function of guidance which is too obvious to be hustled out of court. Add to these the further fact that life is the only definite instance we know in the cosmic scheme that controls the otherwise inevitable increase of entropy: not only does it check the running-down process, it even reverses it by its capacity to build up, restoring the ruins and completing a new edifice.

So we could pass in review mind and personality, which bring with them not only the creative capacity, but the *knowledge* of it. Through these we are introduced to the fact that life in its real nature is immortal—life as it left the hands of the Creator; while at the other end of the series we discover that by the acquisition of this personality something has emerged which can find contact again with the Maker and regain the lost survival. So far from science having effectually closed these avenues, it has actually (when pushed to its final conclusions) only opened them the wider, even providing illumination in many a dark pathway. There are many scientists who now concede that it is possible now and again to reach the surviving personalities who have gone before, although economy of space has compelled me to limit this to the bare statement and give a word of advice about the direction in which reading may be pursued by those who care to follow it.

And so we come to Purpose, with its immense field for exploration. There is no need to retread the ground, but one remark may be added to what was said about the integer 6, that is, carbon, to emphasize its singularity. That it *does* possess the exceptional features which were discussed cannot be gainsaid by physicist, chemist or biologist. It may be urged, however, that it is not altogether strange that one type of atom should stand out in relief from the others, but remember the whole series of atoms presents an orderly progressive increase in complexity. Now the leap in capacities from boron (No. 5) to carbon (No. 6) is amazing, and certainly *a priori* unpredictable. Suppose each atom following carbon had made a corresponding advance on the previous one until we reached the last, uranium (No. 92). No intellect in existence could have hoped to understand the properties of any of the atoms approaching the last in the series. As, however, the elements after carbon resumed their gradual, orderly march up the scale, it leaves carbon in sole possession of its singularity of being the only one which has proved itself equal to being the vehicle of the marvel, life. I do not see how we can escape the conclusion that here is purpose showing the grandeur of the architectural scheme.

Bishop Butler wrote of *natural* and revealed religion. We have travelled a long way since then in our quest of scientific or natural knowledge, and these latter years in particular have shown us clearly that scientific truth can be also a revealed truth—the difference between natural and revealed has largely melted and the two are much more closely merged into one. With wider and deeper knowledge we shall see the dovetailing of the two into a complete harmonious whole. We are, as it were, in the Newtonian stage, and many formerly obscure matters have become increasingly clear; we need but an Einstein to make the last grand correlation and generalization.

Some may be inclined to think that for so large a subject the treatment has been somewhat slight and has left a number of problems untouched. It must needs be so in a limited space, but it is hoped that such as have found a place have been made clear to minds that have no technical training in matters biological. The one thing that plainly emerges is that although we are of necessity bound by a mechanical interpretation to some extent, whatever may be said on its behalf is but partial truth, and this carries its own peculiar danger because it is so easy to assume we have reached an ultimate explanation. For one moment's pause will show us that all through the woven web of life runs the wondrous thread of our Becoming to which we are daily adding. By this we build up an individual personality, rare in experience and rich in achievement, a personality that is untouched, yes, and untouchable by any erosions of disease and unscarred by pitiless time. Lowly in origin we may be, and may carry many relics of such origin, yet we are none the less mighty in promise, a promise that was destined to be ours before the foundations of the world were laid.

I may be only magic dust
   Upon a wild tornado whirled;
I see one lily and I trust
   The love and beauty of the world.
I have no fear, tho' I am blind;
   I have no doubt, tho' knowing naught;
I feel a Spirit lives behind,
   By whose vast love all life is wrought.

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